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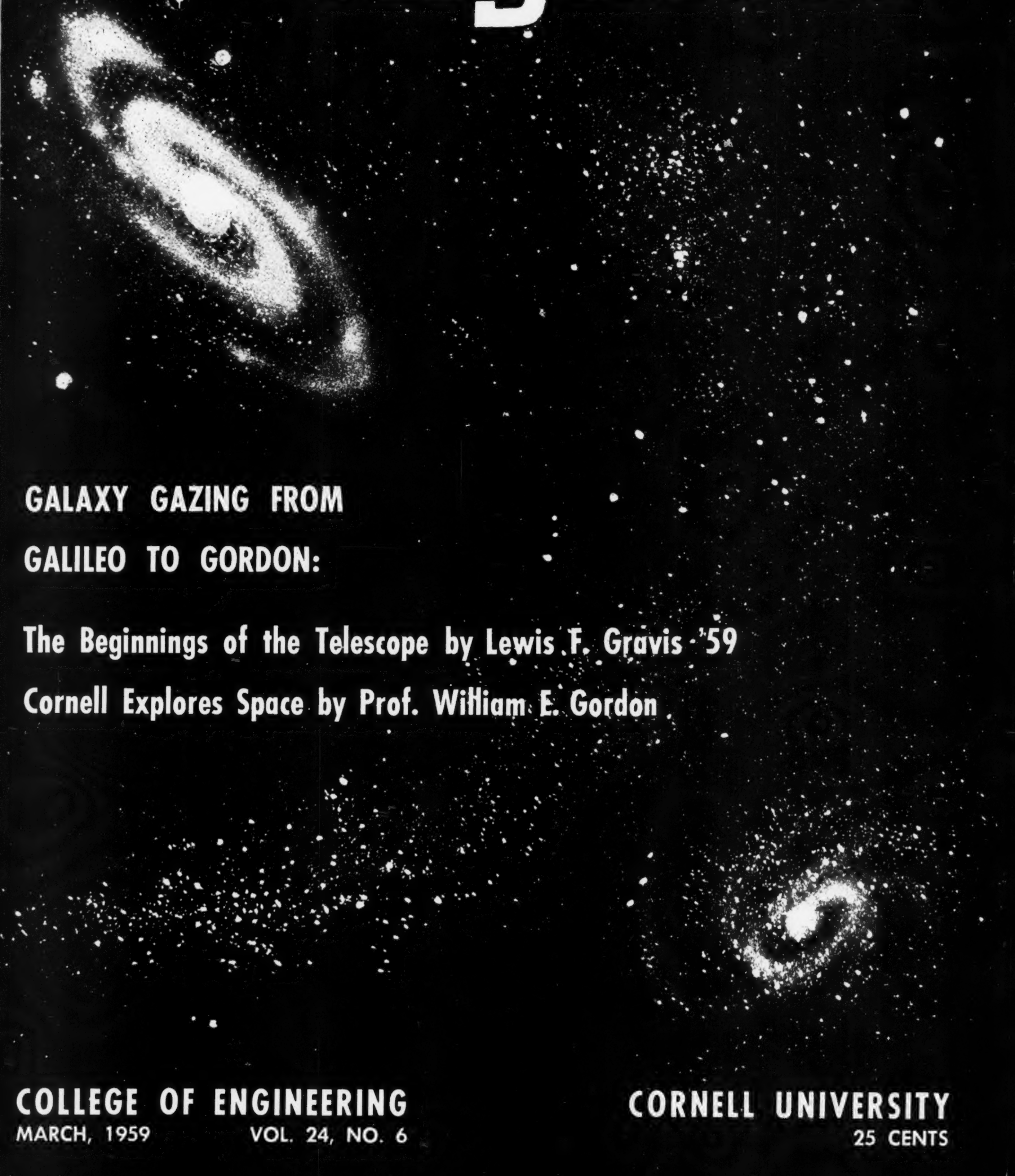

GALAXY GAZING FROM GALILEO TO GORDON:

The Beginnings of the Telescope by Lewis F. Gravis '59

Cornell Explores Space by Prof. William E. Gordon

COLLEGE OF ENGINEERING
MARCH, 1959 VOL. 24, NO. 6

CORNELL UNIVERSITY
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Francis Bacon...on studies

"To spend too much time in studies is sloth; to use them too much for ornament is affectation; to make judgment wholly by their rules is the humor of a scholar. They perfect nature, and are perfected by experience, for natural abilities are like natural plants, that need pruning by study; and studies themselves do give forth directions too much at large, except they be bounded in by experience. Crafty men contemn studies, simple men admire them, and wise men use them, for they teach not their own use; but that is a wisdom without them, and above them, won by observation."

—Essays 50. Of Studies, 1625.

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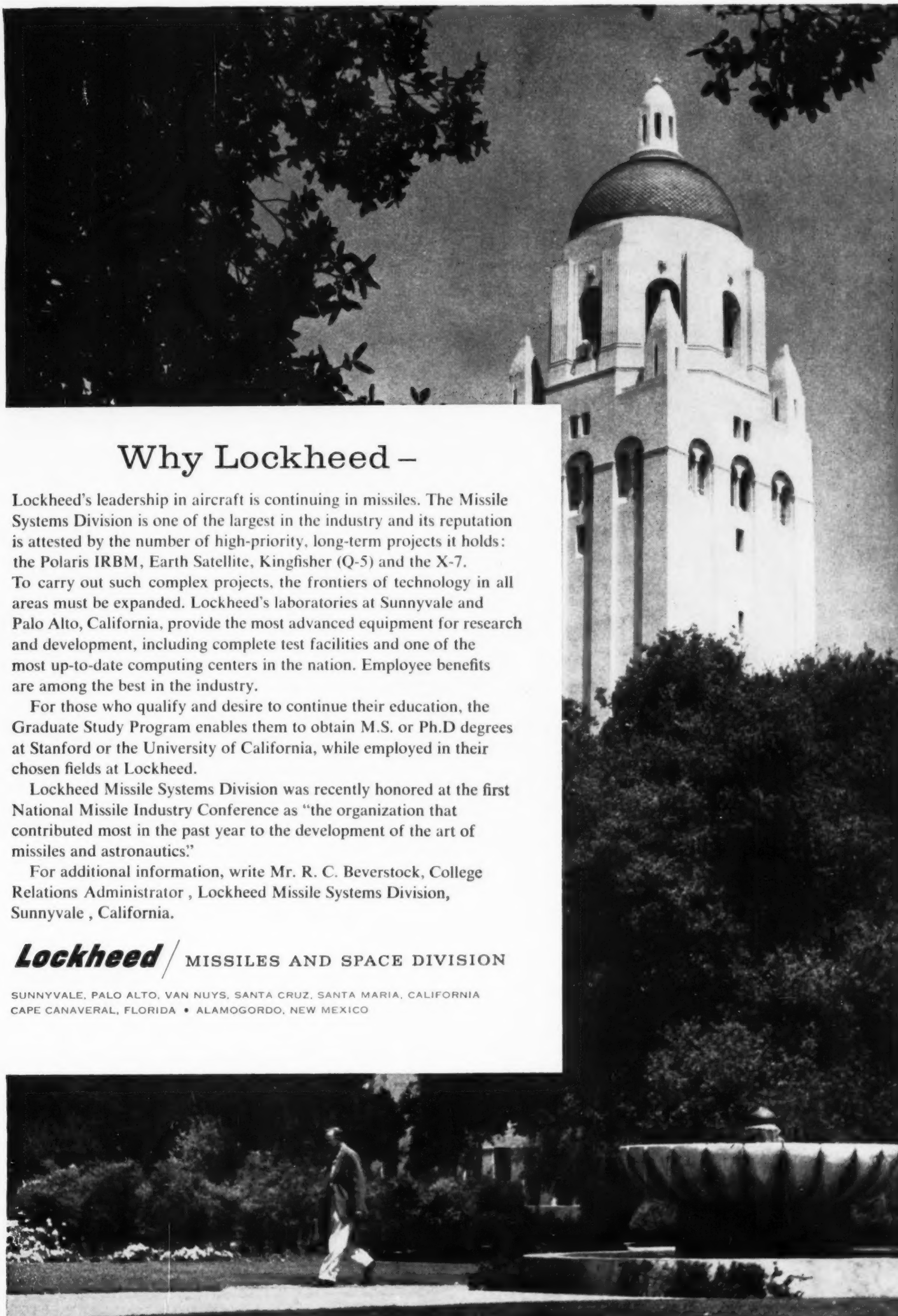

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For additional information, write Mr. R. C. Beverstock, College Relations Administrator, Lockheed Missile Systems Division, Sunnyvale, California.

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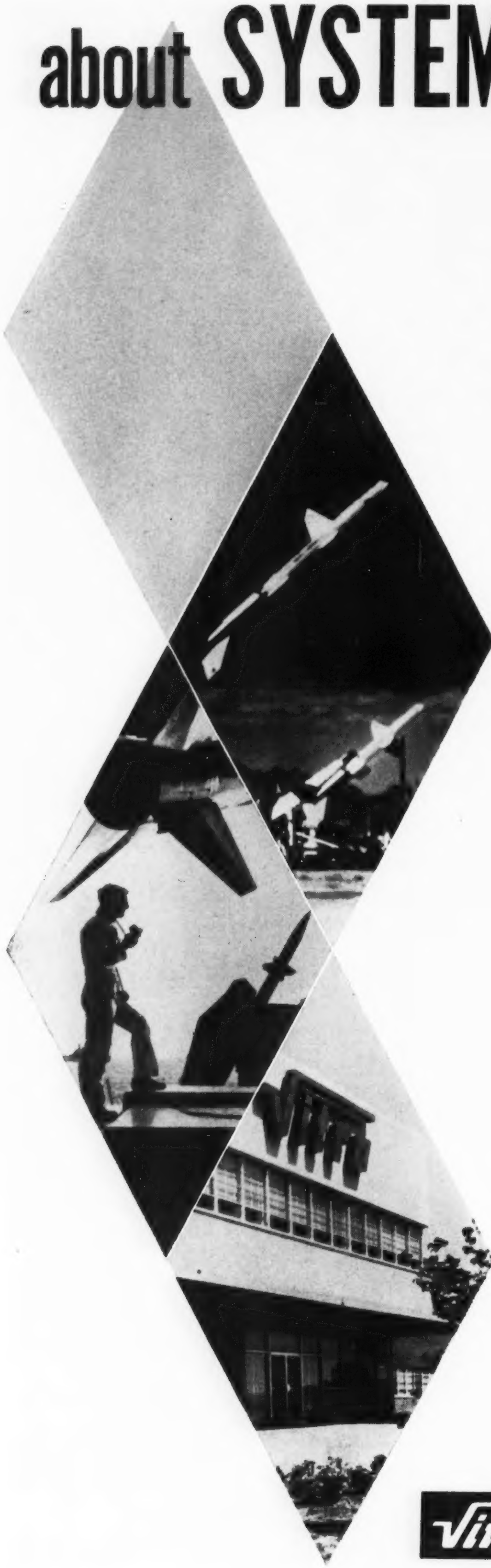
about SYSTEMS ENGINEERING and VITRO



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FRIDAY, MARCH 20,

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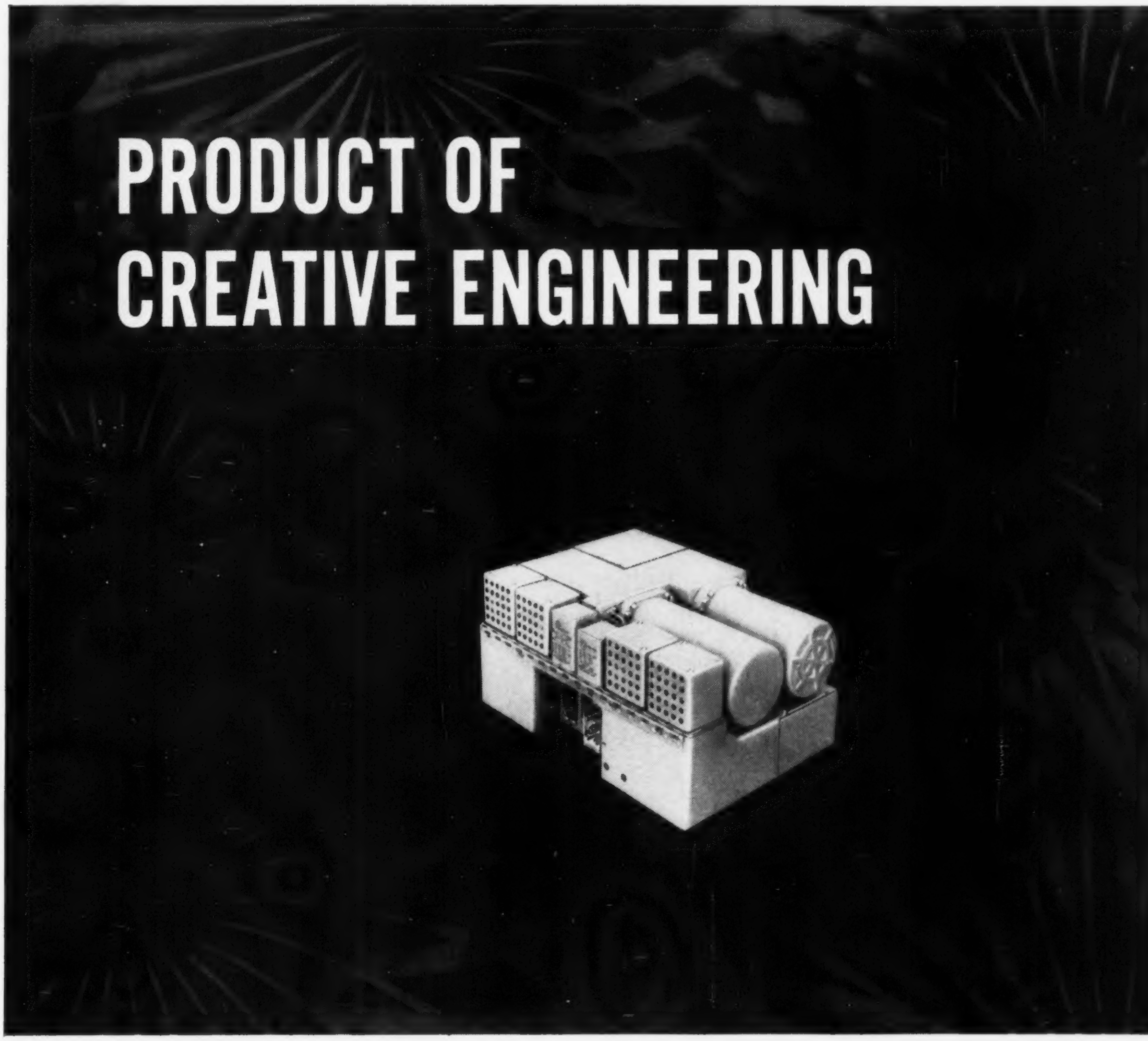

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Editorial:

EQUIPPING OUR SCHOOLS WITH SOVIET APPARATUS

New Soviet scientific equipment to be used in the teaching of physics was recently on display in New York. On the surface, a display of this nature would seem perfectly ordinary. In this case, however, the appearance of the equipment makes us stop and think twice.

The exhibit was not here as the result of some clever counter-intelligence work. It was, in fact, part of a 6,000 piece order of the Ealing Corporation of Cambridge, Massachusetts. The apparatus represented some of the Soviet mass-produced equipment whose manufacturing cost there is so low that this corporation feels it can be sold at a great profit in the United States despite import duties averaging 40 per cent.

To regard these production techniques as a challenge to American industrial ingenuity would not be correct. Professor Sanford C. Brown of the Massachusetts Institute of Technology acknowledges the fact that the equipment is inferior to the physics apparatus produced in this country; however, he does feel that it far surpasses that available in many smaller United States secondary schools.

Does this mean that the Soviets have outstripped us in another area? Are our high schools inadequately equipped in comparison to theirs?

We can not truly feel that this is entirely the case. The past few years have witnessed an enormous expansion in the physical facilities of educational institutions throughout the country. Along with the growth of school buildings has come the purchase of much fine equipment.

Nevertheless, the issue is not to be dismissed lightly. The equipment is highly indicative of the status of Soviet science teaching. It is important to note that it is being *mass*-produced in Russia. This fact would seem to show that standardized apparatus is or will soon be available to their science teachers.

In this country there are no such prospects. At Cornell we are fortunate enough to have outstanding facilities, but they are only maintained through the hard efforts of a farsighted administration.

In high schools, on the other hand, the outlook is not as bright. We often learn of cases in which parent teacher organizations have to step in and purchase badly needed scientific equipment for which school boards had made no budgetary provision. Very often these emergency purchases are rather surprising. It is not uncommon for such moneys to be spent for items that seem far too advanced for secondary school students.

Even more disturbing, though, is the fact that this equipment, being mass-produced, would indicate that Soviet schools are, to a large extent, standardized. In our secondary schools there is no nation-wide standardization. Only at the state level is the initiation of any sort of uniform system possible, and even at this crucial point, few states take the necessary steps to bring it about. How valuable some centralized educational system would be in establishing intelligent policies in the face of the present Soviet challenge!

The consequences of these lacks of basic concepts and standardization in secondary schools (with which the Soviet Union is apparently not confronted) are all too plain. Much time is spent in our universities going over basic work which should and could be taught in high schools.

With the present hodge-podge of scientific studies in our high schools, it is no wonder that American manufacturers do not mass-produce basic technical apparatus comparable to that of the Russians. The introduction of these new Soviet products provides an excellent opportunity for some much needed revision of our secondary school scientific instruction. We earnestly hope that this standardized apparatus will provide the needed impetus for a uniform high school science program. Finally, the basic nature of the devices should force instructors to place more emphasis on first principles which, in recent years, many educators seem to have let fall by the wayside. —A.S.R.

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THE CORNELL

engineer

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COVER: Design by Jeffrey Frey

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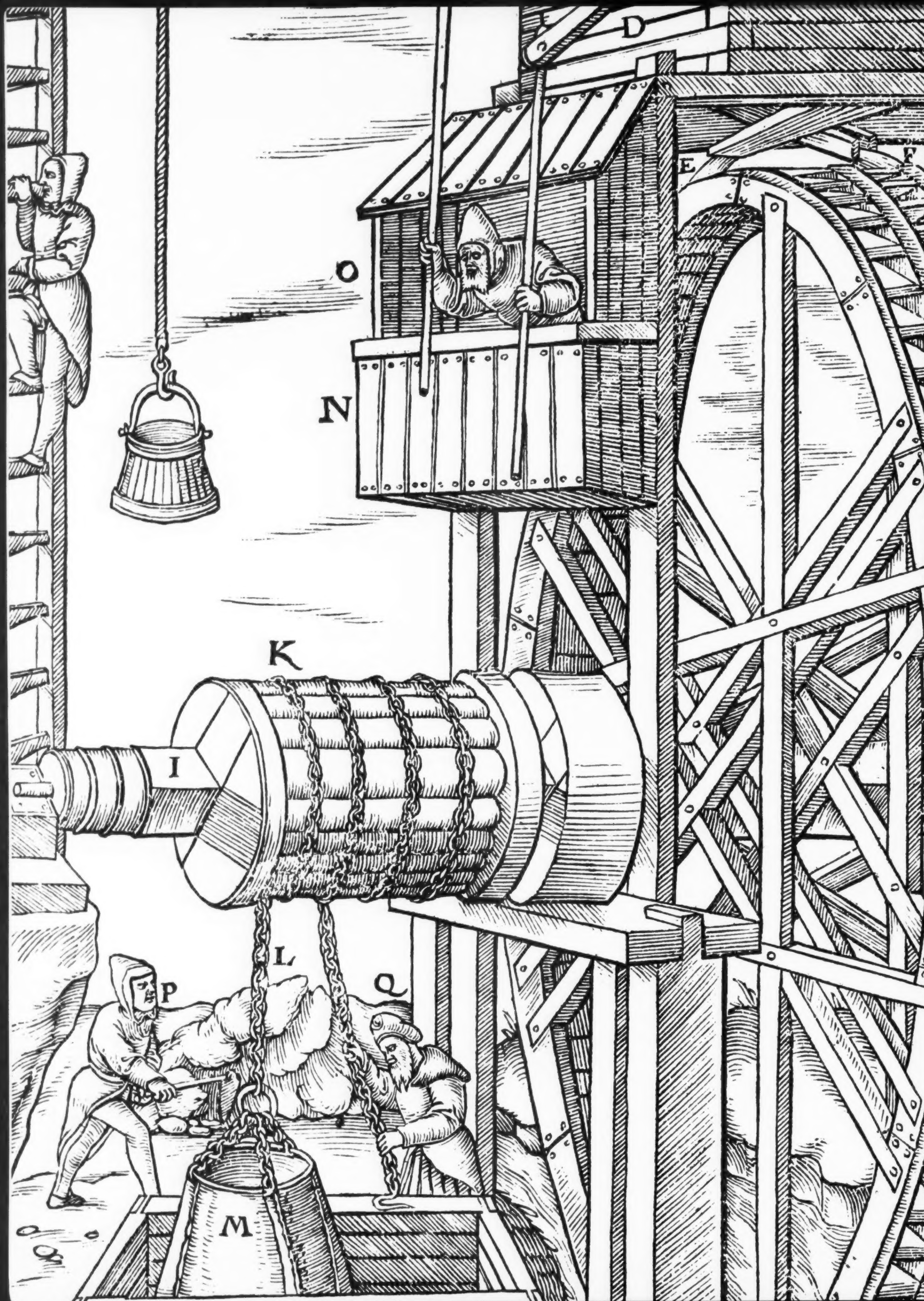
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THE SIXTEENTH CENTURY MINING INDUSTRY

A PREVIEW OF THE MACHINE AGE

by Roy J. Lamm, ChemE, '61

During the fourteenth century the rapid output of minerals and metals that had been characteristic of Europe for several generations came to an end. The production of gold and silver along with several other metals declined. This slump apparently was not isolated to the mining and metallurgical industries but was rather widespread throughout the European economy. In the case of the metallurgical industry, one of the chief causes was the exhaustion of good ore bearing seams and the crude, inefficient ore processing methods in general practice at the time.

As a rule shaft mining, if used at all, seldom penetrated very deep. The usual method was to cut into a hill to reach a sloping seam with many small, shallow pits. Washing, crushing, and handling of ores was done out of doors almost entirely with hand labor.

In order to meet the shortage of rich ores and the rising cost of labor, better mining and metallurgical techniques had to be developed. New, deeper seams had to be worked. This required better methods of draining and supporting the mine shafts. More efficient ore processing and metal extraction methods had to be developed. In short, another source of power in addition to man's muscles was needed.

Simple water driven machinery was introduced in the fourteenth century to drain mines, drive bellows and power hammers. In addition larger, more efficient furnaces were developed. However, in most of Europe the mining, smelting, and refining of metal remained to a large degree antiquated. Europe, it seems, was in less a mood for exploration or discovery than in the gothic age. In the second half of the fifteenth century, however, this mood changed, and while some explored beyond the seas, others turned full force toward improving the metallurgical industry of Europe. While in the Middle Ages it was thought debasing for someone of learning to work with such material pursuits, the revolution in mining and metallurgy in the fifteenth and early sixteenth centuries brought together men of learning and mining men. Their efforts resulted in a burgeoning, revitalized mining and metallurgical industry. Water power was used extensively in complex pumps, multiple crushing machines, and powerful bellows. Rows of furnaces enclosed in large buildings produced much greater quantities of metal.

By the mid sixteenth century mining and metal working communities in Central Europe, especially in Germany, were bustling with industrial activity. Unlike most manufacturing of the day, which was still carried on by individual craftsmen, the mining and metallurgical industry was relatively well-advanced in industrial technique. Using power operated machinery, mechanical ventilating systems, materials handling equipment, and assembly line methods, many mines would employ hundreds of skilled men organized in ways foreshadowing our modern factory system.

Mechanical Equipment

The most significant feature of this age was the equipment used. Much of the simple equipment used during the sixteenth century as the block and pully, the windlass, the use of water wheels, the transmission of power through shafts, and gear wheels was described by Ctesibius of Alexandria (c. 250 B.C.) and Archimedes (c. 230 B.C.). However, many newer more complicated machines applying the principles of the mechanical components listed above were introduced during this century.

As stated earlier, one of the depressing factors in the mining industry had been the inability of miners to work veins much removed from earth's surface. As soon as shafts were dug they would fill up with ground water. The introduction of pumps, although at first quite crude, enabled miners to go at least some distance underground. As larger and more refined pumps were developed during this period, shafts could be sunk hundreds of feet below the surface and still be drained.

The most ingenious, durable, and useful pump of them all is shown in figure one. This pump, like most of the large power equipment used at that time, is run by means of a water wheel. The water wheel, top left, is supported on a shaft H set in bearings on heavy columns. The shaft terminates in a crank which moves vertical rod I. The rod's lower end through linkage moves the uppermost of three pumps F through its piston rod M. The other linkage K operates on the second pump D. Similarly, this also pivots on an arm to operate pump B. Each pump empties into a basin from which the next one draws until finally the uppermost pump empties its water into the sluice G. This pump was invented about 1546.

Of equal interest is the ball and chain pump. This pump shown in figure two is also driven by a water wheel which is usually twenty-four or thirty feet in diameter. Connected directly to the power shaft B is a wooden drum E to which are fastened at regular intervals iron clamps. The clamps catch the links of the chain which dips down

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Figure 3: This is the largest machine employed during this period to pump water. The water wheel powering the pump has two sets of blades oriented in opposite directions thus enabling a reversal of the shaft direction.
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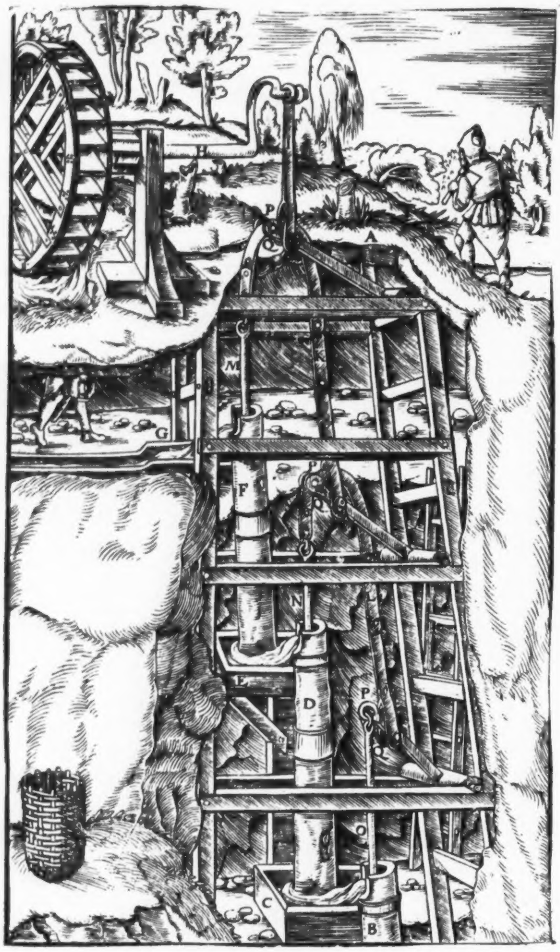

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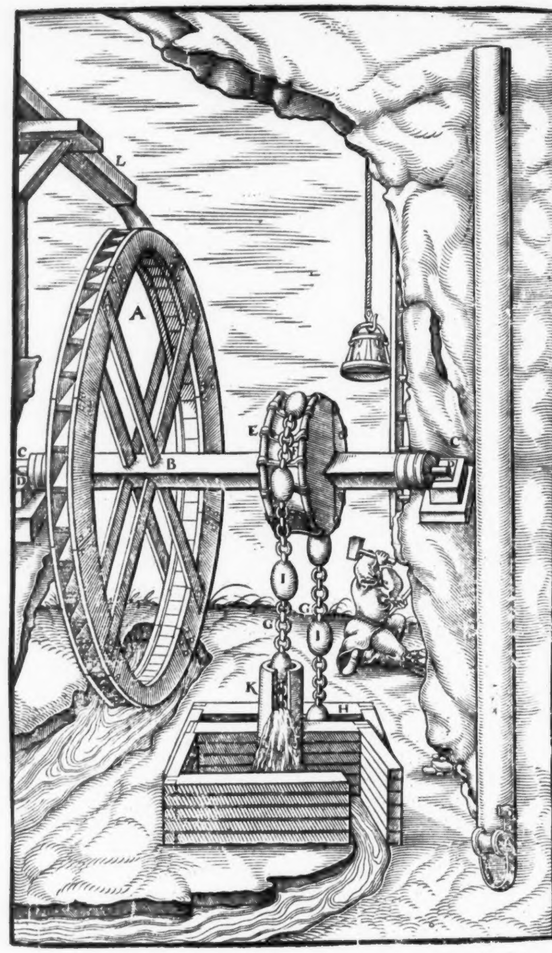

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Figures 1 and 2: It took compound machines, powered with water, to pump out mines which went to any great depth below the earth's surface. These machines were products of the mining revolution of the 15th and 16th century. The machine at the left was invented about 1546. The ball and chain pump at the right is slightly older.

through a conduit to the sump of the mine where it passes over another wooden drum. As the large wheel turns the chain, the drum draws up the balls I which trap water in the conduit acting as a one-way piston.

Lastly, the largest machine of all to draw water is shown in figure three. The water for the water wheel is derived from the reservoir shown at the upper right. This water empties from two ports pointing in opposite directions over the large water wheel which has two sets of blades tilted in opposite directions. In this way the wheel can be shifted from operating in one direction to the other direction by merely pulling a lever. The wheel turns the large horizontal axle K about which a chain can be wound. At each end of the chain is a large bucket. Thus while one bucket is being hauled up full of water another is traveling downward to the sump to be filled.

The necessity of ventilating systems was recognized as shafts and tunnels went deeper into the earth. In order to renew the air, several types of ventilating machines were employed. Probably the most efficient and practical consisted of a large hollow drum mounted on an axle which was powered by a water wheel. Inside the drum a set of wooden paddles turned with the axle forcing air out a hole on the circumference of the fixed drum. This air when directed down the shaft was sufficient to replenish the foul air.

Ore Processing

Undoubtedly direct smelting of ore as it was mined accounted for the earliest recovery of metal in ancient times. But the obvious advantage of separating the gangue before smelting probably occurred to metallurgists fairly early in history. The Greeks and Romans used mortars and millstones to crush the crude ore and washing to concentrate it. As Strabo relates, "But as for the silver ore collected, he (Polybius) tells us that it is broken up and sifted through sieves over water; that what remains is to be again broken, and the water having been drained off, it is to be sifted and broken a third time."

The expanding metal industry of the late fifteenth century, however, could not depend upon unlimited slave labor for sorting and concentrating ore. Instead, they again turned to water power and devised

multiple stamp mills for crushing the ore and jigs for sifting and sorting the ore mix.

The stamp mill seems to have been invented sometime in the late fifteenth or early sixteenth centuries, but who invented it is unknown. A multiple wet stamp mill is shown in figure four. It consists of an oak frame with a timber bed. On the bed sets a mortar box for each stamping unit; in this example there are four such boxes. Two sluices shown at the upper right power water wheels A and D while two others below them power wheels G and K. As the shaft connected to the water wheel turns, cams fixed to the shaft alternately lift the tappets connected to the stamps. When the cam and tappet disengage, the stamp whose bottom surface is sheathed in heavy iron drops and subsequently crushes the wet ore in the mortar box. The resulting wet powdered ore filters through strainers into the long transverse lauder moving at floor level to the right. A man with a scrubber agitates the water permitting the heavy metallic particles, usually gold, to settle to the bottom.

Another fine example of the mechanized equipment and methods that were employed at that time is an assembly of units that could crush, grind, and wash gold ore and in the final stage mix the ore with mercury for the final recovery of the gold. This machine shown in figure five operated a stamp mill C which crushed the large chunks of crude gold ore. The ore could then be transferred across the race into the mill F where it was fed into the center of the upper millstone. The ground ore issued in powdered form to the first of three adjoining tubs filled with mercury and agitated with paddles connected by gears to the main power shaft. As agitation progressed a gold amalgam formed, leaving the water to carry away the waste material. When the amalgam was placed in an alembic, the mercury could be distilled off with slight heating leaving the gold.

It was combined processes like these which, although not practiced universally in every mine in central Europe at this time, were indicative of the applications of powered machines instead of human or animal brute force to industrial production.

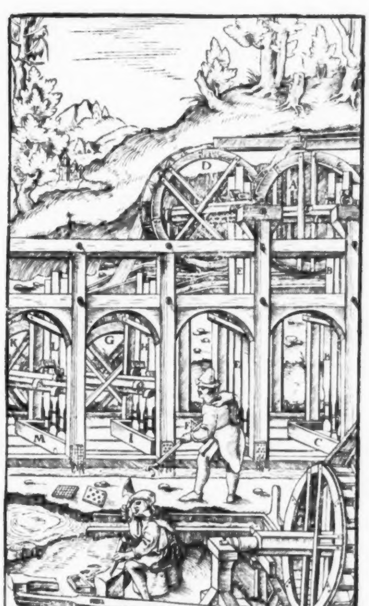

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Figure 4: Because the expanding metal industry of the 15th century could not depend upon unlimited slave labor for sorting and concentrating ore, complex stamp mills and jigs for crushing and sorting were devised.

Iron

The application of water power to mining equipment also appears to have been an integral factor in the evolution of the blast furnace and the production of cast iron. Before the fourteenth century in Central Europe bellows powered by hand or with animals were used to obtain higher temperatures and better oxidation of iron ore in the smelting furnace. Gradually, however, larger bloomery furnaces were built in order to get larger amounts of crude iron. These furnaces required larger more powerful bellows. The great profusion of rushing streams tumbling down mountain slopes into the valleys probably led some ingenious metal processor to the use of a crude water wheel to drive the larger bellows.

This probably was the first application of water power in this area to the production of metals. The larger bloomery furnaces or *Stuckofen* were intended by their designers to merely produce larger masses of wrought iron under the same conditions as their progenitors the forge. The furnaces with bellows attached (*Blasofen*), because of their higher temperatures, however, yielded, instead of a pasty mass which had to be hammered to remove the slag from the iron, molten metal which could be drawn off and cooled in a mold. Slowly the technology of this new "cast iron" developed from this simple, accidental beginning.

By the end of the fifteenth century this new skill had advanced to a relatively refined state. Molten metal was drawn off periodically from a tap hole from the hearth at the bottom of the furnace into open oblong molds called "sows." As larger amounts of metal were made adjoining molds perpendicular to the sows were introduced. These, because of their orientation to the large mold, were called "pigs."

Since the molten metal in these blast furnaces was in contact with the charcoal for a longer time, as it made its way to the bottom to be drawn off, its carbon content was considerably higher than the carbon content of wrought iron that had been produced from forges for centuries. Because of this, it lacked ductility and tensile strength and

(Continued on Page 35)

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Figure 5: A fine example of the mechanized equipment and methods employed at this time is this assembly of units that could crush, grind, and wash gold ore and in the final stage mix the ore with mercury for the final recovery of the pure gold.

CORNELL EXPLORES SPACE

by Prof. William E. Gordon

Cornell has proposed a powerful radar to explore the earth's upper atmosphere and surrounding space, because it was discovered[1] that a certain electron scattering cross section too small to be considered heretofore is large enough to detect with a powerful radar. This opens the way to measuring continuously for the first time electron density and electron temperature as functions of height and time from heights of a hundred to several thousands of kilometers above the earth. Other exciting prospects are mentioned in the reference including the possibility of observing some of the planets by radar. Cornell proposes that the facility be operated to promote staff and graduate student research as appropriate in a university.

The radar consists of a powerful transmitter, a sensitive receiving system, and an antenna larger than any now known to exist. The transmitter-receiver components are selected from the best of the present state-of-the-art. The antenna, too large to fit in Schoellkopf, presents a challenge to engineers. It will be made by adapting a natural site having approximately the right dimensions.

If the radar is to see the planets, (and the sun if it will reflect enough energy) it must be located so that the planets will come into its view. Now, the proposed antenna is so large that the ability to move the beam about in the sky will be severely limited, so it requires a tropical or near tropical site where the planets pass overhead and a natural ground formation that can be economically adapted to the radar antenna specifications exists. Puerto Rico has areas that meet both of these requirements. Limestone sink holes having approximately the right dimensions for the antenna are available.

The radar design objectives are to use components that are within the state-of-the-art so that the radar can be assembled immediately and to provide the sensitivity with which to measure the density of the electrons that is believed to exist at heights up to 1,000 kilometers or more in about a second of time. (Resolution in time and in density may be traded to some extent.)

[1] (PIRE, vol. 46, p. 1824, 1958)

The Purpose

The discovery that free electrons in the earth's ionosphere incoherently scatter signals that are weak but detectable with a powerful radar makes possible the exploration of the upper atmosphere and surrounding space by radar. The fact that the radar components, while sensitive, are all within the state-of-the-art means that the exploration can begin as soon as the radar is assembled.

The radar for the first time will measure directly the electron density and electron temperature as functions of height and time through the ionosphere, not only in the recognized layers, but also between and above them. The formation and disappearance of these layers, their structure, and the diurnal and seasonal changes in them will be observed. These observations should contribute substantially to our understanding of the ionosphere and its effect on radio waves.

In addition to exploration of the ionosphere, the radar has the following exciting capabilities: a) the observation of transient streams of charged particles traveling through space near the earth, b) the search for the existence of a ring current around the earth, c) radar observation of the planets Venus and Mars and an improved measurement of the astronomical unit of distance, d) the possibility of radar observation of the sun and its irregular atmosphere, e) the sensitivity to observe heretofore undetected radio stars in a limited region of the sky.

The primary design goal has been based on the exploration of the ionosphere and is stated in terms of observing 1,000 electrons per cubic centimeter at a height of 1,000 kilometers using radar components within the state-of-the-art. This goal has been achieved in such a way that the other capabilities listed above can also be realized.

The capability of the radar in the solar system is limited in part by the available motion of the antenna beam. The rotation of the earth on its axis scans the antenna beam through the solar system at a rate of ¼ degree per minute. During the time it takes for the radar pulse to travel to a solar system target and back, the antenna beam will move an appreciable amount, making it necessary to be able to position the beam so that the angle scanned during pulse transit may be removed. The beam is scanned four degrees during the sixteen minutes of round trip travel of the radar

About the Author

Professor William E. Gordon began his studies in radio-meteorology and astronomy while in the Air Force during the war. He came to Cornell in 1948 as a research associate in the School of Electrical Engineering. In 1953, he received his Ph.D. here and that same year was appointed Associate Professor of Electrical Engineering.

pulse to the sun. The planets Mars and Venus might be observed when they pass closest to the earth when the travel times, and therefore the angular scans, are smaller than those of the sun. To include the possibility of radar observation of the sun and the planets at their shorter ranges, it will be possible to position the beam within a few degrees of the antenna axis.

The solar system capabilities also depend, for this beam of very limited mobility, on the original pointing of the beam, and on the sensitivity of the radar. The pointing of the beam has been based on the best solar system target, Venus, at its nearest approach, April 1961. If the reflection coefficient of Venus is no worse than that observed for the moon, then in the spring of 1961 there will be many opportunities to observe the planet with a signal-to-noise ratio of the order of ten or more on the individual pulses.

The Radar

The transmitter requirements are based mainly on the calculations of the ratio of echo power to noise fluctuations for echoes received by scattering from free electrons, neglecting the effect of the earth's magnetic field. To achieve the desired sensitivity, the pulse energy should be of the order of ten to twenty thousand joules per pulse. Since a reasonable maximum value for the duty cycle is 6 to 10 per cent, the transmitter should have an average power capability of 100 to 150 kilowatts, with peak power capability of about two megawatts, and a maximum pulse width of ten milliseconds.

Since the transmitter is to be used as a research tool, it should be as flexible as possible. For close examination of ranges where the signal-to-noise ratios are high, the pulse width should be shortened for finer range resolutions. In these cases it should be possible to increase the pulse repetition frequency to keep the required observation time to a minimum.

The pulse shape requirements are based on the desire to measure the electron temperature. The thermal motion of the electrons will spread the frequency spectrum of the transmitted pulse. To measure this spread the energy content of the transmitted pulse should be contained in a relatively narrow frequency band.

A receiving system to be used with the powerful transmitter and large antenna should be the most sensitive available and be flexible and complete enough to obtain the maximum possible information from the returned echoes.

The possible sensitivity of the receiver can best be specified in terms of the effective noise temperature. Contributions to this noise temperature come from the sky, the ground, losses in transmission lines, and the first stages of the receiver.

The sky temperature for a narrow beam antenna directed at the zenith varies with frequency, the location of the antenna, and time of day. The proposed antenna will actually survey the portion of the sky involved in more detail than any previous survey. At 400 megacycles per second the sky temperature will be less than twenty degrees Kelvin for about sixteen hours a day, and always less than 100 degrees Kelvin.

The contribution of the ground to the noise temperature depends on the degree to which the antenna illuminates the ground. Transmission line losses of 0.5 decibels will add 36 degrees Kelvin to the noise temperature. For a zenith-looking antenna the total contributions of

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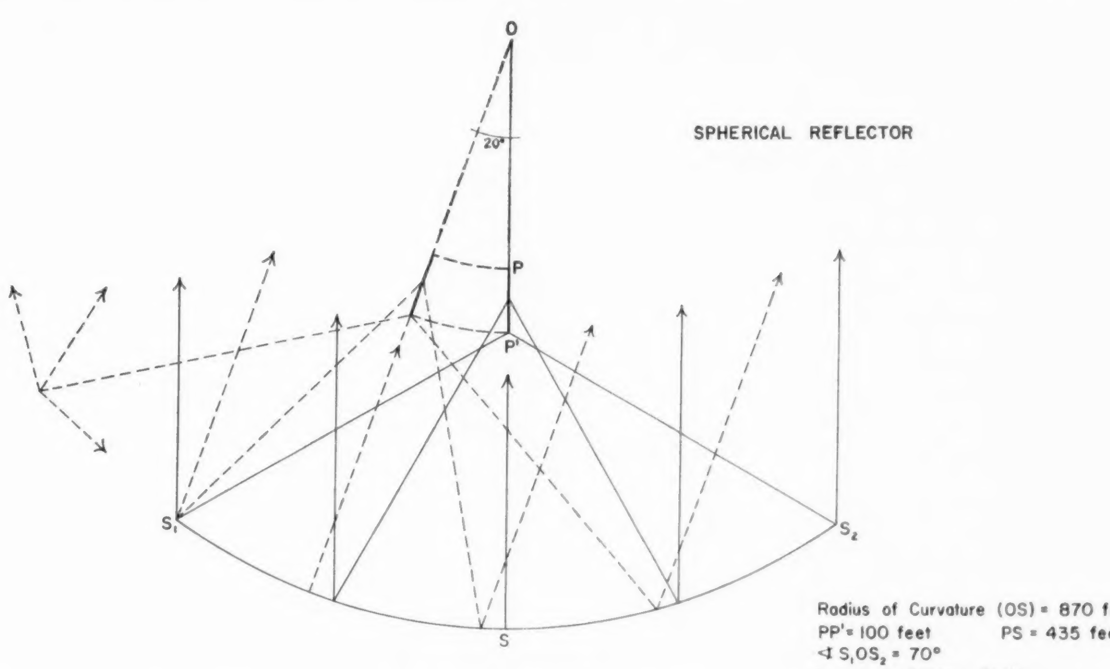
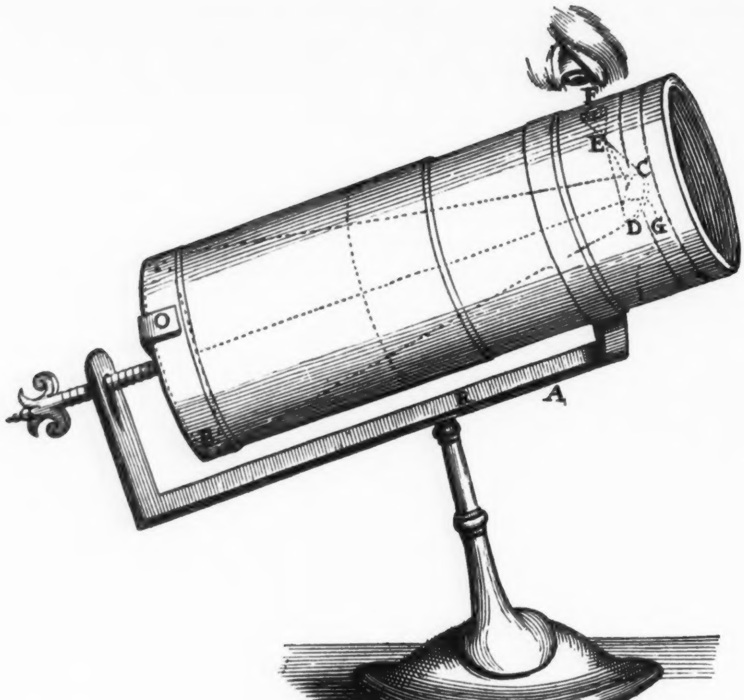


Figure 1: In order to increase the beam swinging ability, and still keep the reflector fixed, a spherical reflector as an alternate to the paraboloid reflector is being considered. The reflector would have a radius of curvature of 870 feet and an aperture of 1,000 foot diameter. The feed to correct for the resulting spherical aberration is a line source approximately 100 feet long 355 to 435 feet above the reflector.



Newton's reflector consisted of a spherical mirror and a flat secondary mirror plus the necessary eyepiece. The secondary mirror was inclined to re-reflect the light from the primary ninety degrees into the eyepiece located on the side of the tube.

THE BEGINNINGS OF THE TELESCOPE

by

Lewis F. Gravis

ChemE '59

Beginning in the early part of the seventeenth century, the telescope began to find its place in astronomy. In the hands of men like Galileo, Kepler, and Newton, it was a major factor in the acceptance of the Copernican Theory of the universe over the well-established Aristotelian Theory.

Galileo Galilei was the first person to use the telescope effectively in astronomical work. He was born in Pisa in 1564 and grew up in an age of relatively intense intellectual turmoil. Contrary to his father's hopes that he aspire to the medical profession, the young scholar's interests wandered to mathematics as applied to practical problems. A result of this mathematical investigation was Galileo's distaste for the pure Aristotelian physical concepts of his time. Galileo's intense interest in the physical world around him and his keen observations of nature were factors which led him both to a search into the validity of the cosmological theories of the early seventeenth century and to a desire to develop instruments to make more accurate observations and experiments.

After hearing a rumor that a Dutchman had constructed an instrument which would allow a faraway object to be seen distinctly as if it were near, and after getting confirmation of the above report from a Paris friend, Galileo in 1608, journeyed to Padua where he designed and constructed his own telescope. This is but one of the innumerable ways in which Galileo showed his mechanical genius, and, beyond a doubt, one of the most important. He gives an accurate description of his first telescope in the *Sidereus Nuncius:*

"a tube, at first of lead, in the ends of which I fitted two glass lenses, both plane on one side, but on the other side one spherically convex, and the other concave. Then applying my eye to the concave lens I saw objects satisfactorily large and near, for they appeared one-third of the distance off and nine times larger than when they are seen with the natural eye alone."

Telescope Used in Astronomy

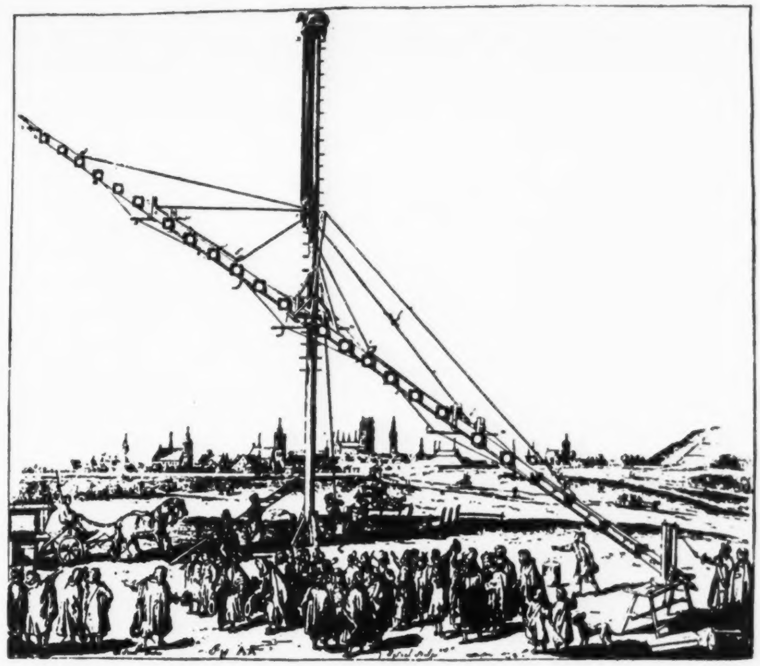
After making several more telescopes, some with a lens system to re-invert the image, Galileo conceived the idea which was to be the greatest advancing agent in astronomy since the first philosopher had tried to discover the true nature of the universe. Instead of being content with merely observing distant ships with his telescope, he decided to use it to investigate the heavens.

The observations Galileo made on the heavens shook the scientific world. His discoveries disproved many theories that were well ingrained in the minds of his contemporaries.

One night, while observing, Galileo discovered that the moon, instead of being a perfect sphere with a smooth unblemished surface as had been believed from time immemorial, was actually quite different. Through the telescope the moon had an extremely rough surface well studded with massive mountain ranges, including some mountains whose height, he estimated, frequently exceeded the height of the tallest mountains known to exist on the earth at that time.

After observing Jupiter several times with inferior telescopes Galileo built a remarkably good telescope with a magnification of about thirty diameters. On January 7, 1610 he observed Jupiter with his new instrument and discovered what were later proved to be four satellites of the planet.

When he pointed his telescope to the Milky Way, Galileo was confronted with more stars than man had ever imagined existed. His observations settled many of the disputes over the nature of the Milky Way. He was also able to compare somewhat quantitatively the magnitudes of stars invisible to the naked eye with the magnitudes of visible stars.



Many of the early astronomers built huge telescopes with focal lengths up to 150 feet. Some valuable astronomical observations were made with these monstrous instruments. Their great fault was that it was almost impossible to keep a celestial object in view for any length of time.

Galileo Advances Copernican Theory

Galileo published all of his new findings, but, although he was a staunch supporter of the Copernican theory of the universe, he wisely made no attempt to correlate his findings with this theory. Even so, he met with strong opposition from the Aristotelian astronomers and was forced to defend against bitter attack the theories he formulated from his observations. In addition, there were those who were so implicated by the attacks of Galileo that they could not "lose face" and publicly recognize the importance of Galileo's remarkable discoveries.

It is quite fortunate that Galileo had Johannes Kepler as such a good friend. The two men never met personally but corresponded frequently. It was to Kepler that Galileo first disclosed he had discovered that Venus showed phases as the moon did. This was a bitter blow to the Aristotelians, for they had long argued that if the planets revolved around the sun, Venus and Mercury, like the moon, would show phases.

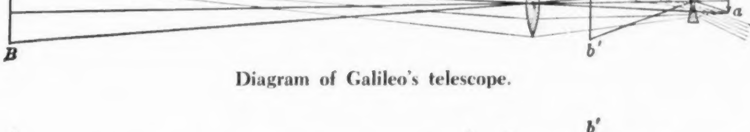


Diagram of Galileo's telescope.

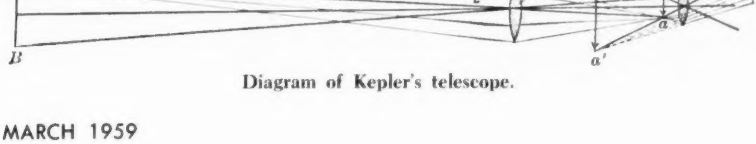


Diagram of Kepler's telescope.

Copernicus had indeed predicted this phenomenon. This was now substantially proven. Yet, many still would not allow the earth a lesser position in the heavens by accepting the Copernican system. This new discovery did much to increase the hatred of the Aristotelians for Galileo, as did Galileo's discovery of sunspots and his subsequent speculations about the revolution of the sun.

Galileo made many more observations but found that he could no longer speak his beliefs freely, for the church had prohibited the teaching of the idea that the sun, rather than the earth, was the center of the solar system and that the earth, along with the other planets, rotated about the sun. Nevertheless, Galileo, after his friend Cardinal Barberini was elected Pope, published another book in which he skillfully laid down arguments for the Copernican theory while at the same time, by giving some discussions seemingly in favor of the Aristotelian cosmology, veiled from the eyes of the Office of the Holy Inquisition his true purpose, that of defending the Copernican system. This book was the instrument which led to Galileo's trial.

Galileo's later telescopes had the advantages of an erect image and a brightly illuminated field, which made them, as well as excellent instruments for military and personal use, invaluable for astronomy. Among other improvements, Galileo formulated the idea of stopping down the objective and ocular to promote better definition, at the expense, however, of light gathering power. All Galileo's telescopes had both chromatic and spherical aberration, which is quite understandable in as much as nothing was known about these two phenomena at the time.

By the use of an objective with a positive focal length and an ocular of negative focal length Galileo obtained excellent definition for the size and quality of his instruments. This arrangement is still incorporated today in the Barlow lens for the same purpose, and of course there is a multitude of cheap Galilean telescopes on the market, used mainly for navigational instruments.

Some mention of the importance of Galileo's observational techniques should be made. Techniques which are important because they showed a relatively new method of approach to scientific problems. Galileo refused to disclose the occurrence of any phenomenon that he observed until enough careful observations had been made to prove beyond a doubt that what he saw was undeniable fact and not an optical illusion. He then—and not before—disclosed the occurrence either in a letter or verbally to a friend or assistant. This practice even today remains the basis of sound observational technique.

Galileo's observations and discoveries were factors which prompted scientists and astronomers of the seventeenth century to try to improve the telescope so that more exact and significant studies of the heavens could be made. A new field of learning had opened up and the subsequent development of the basic instrument of that field is of great interest and importance.

Telescope Improved By Kepler

Johannes Kepler had several telescopes made under his own direction and later made a number of design improvements on their optical systems. Although a student of Tycho Brahe, a staunch opponent of the Copernican system, for a short time before Brahe's death, Kepler was as enthusiastic in trying to prove the validity of the Copernican cosmology as was his good friend Galileo.

Through experiments, Kepler discovered that refraction depends on the density of the transmitter and not upon its nature, as Brahe had thought. With a telescope as an aid, Kepler made further studies in refraction which led to his discovery of spherical aberration. He published his findings in *Dioptrice* (1611), which included a theory on a hyperboloidal form for a lens postulated on studies made of the human eye.

In the *Dioptrice,* which was to be the handbook of lens makers for decades, Kepler also devised a new lens combination with a positive focal length objective. This system gives an inverted image. However, this fact is of no consequence in astronomical observations for obvious reasons.

The greatest advantage of the Kepler telescope is that it gives a larger field than the Galilean telescope of similar dimensions. This can be easily seen by comparing the ray diagrams of the two telescopes.

There are three principal differences between the Kepler and Galilean telescopes besides the obvious difference in the type of curvature of the lenses. In the Kepler telescope a real image is formed in the front focus of the ocular, the rays passing through the ocular are refracted inwards instead of outwards, and an object placed in the image plane is magnified along with the image. This makes both for a large field and for good magnification. Although the Kepler telescope is excellent for wide field astronomical use, there is little evidence that Kepler used his own design to any extent, probably because he recognized his own weakness in observational technique.

Although Kepler made very few telescopic observations, some of the naked eye observations he made were extremely important. The existence of the nova of 1608 and his observations of it did as much to upset the Aristotelian tradition of a fixed number of stars in the universe as did Tycho Brahe's writings. This discovery was one of many that finally elevated the Copernican theory to its proper place in astronomy.

Long Focal Length Telescopes

Chromatic and spherical aberration, which were to a great extent inherent in the Galilean telescope and impossibly bad in the Kepler telescope, became more and more pronounced in distortion of the image as the power of the telescope was increased. Descartes corrected the situation somewhat when he published his *Dioptrique* in 1637. In this work he discussed the properties of concave and convex lenses in combination and singly, and proved the causes and effects of spherical aberration by the use of what was to be later known as Snell's sine law of refraction.

Descartes, like Kepler, proposed the use of an aspherical lens surface (hyperboloidal) to correct aberration. However, with the equipment at hand and the quality of the glass available, Descartes was unable to produce a lens with a true hyperboloidal surface. Descarte's failure to differentiate between chromatic and spherical aberration was an unfortunate mistake, but his suggestion to increase the focal length of the objective did help to achieve high magnification and relatively good definition with a minimum of spherical aberration.

Following Descartes's suggestion, many of the early astronomers built huge telescopes with focal lengths of up to 150 feet. Some valuable astronomical observations were made with these monstrous instruments. Their great fault was that it was almost impossible to keep a celestial object in view for any length of time. Rope and pulley systems were often employed to adjust the lenses, but the entire system could be set into violent vibration by the slightest breeze. For this reason, they made few discoveries.

The Reflecting Telescope Appears

As any complex instrument goes through the early stages of development, or is apparently completely developed, substitute instruments which do away with some of the faults or drawbacks of

(Continued on Page 54)

ACETYLENE PRODUCTION

by Makoto S. Shimada, Grad. '58

First used only for illumination, acetylene later became a basic chemical for the metal working industries where the very high temperature obtainable from an oxy-acetylene flame, about 6,000 degrees Fahrenheit, made it of prime importance for welding and cutting. And now, the versatile gas is already, or is potentially, the starting point for a perplexing array of important industrial organic chemicals.

Some 75 per cent of the acetylene produced today is a raw material for chemicals. It is a basic building block for vinyl acrylic plastics and fibers and nitrite rubbers. In some of these chemical applications, acetylene has the field entirely to itself.

While there are several processes for the production of acetylene, the calcium carbide method has long been the mainstay of the industry. Its advantage lies in the highly pure acetylene it gives. Its disadvantage, at least for large plants which usually are demanded by the acetylene user, is that its use is somewhat restricted to areas of plentiful, cheap electric power.

Challenging the long-established process of calcium carbide for chemical acetylene are numbers of processes using hydrocarbons. All hydrocarbon acetylene processes are basically the same, *i.e.*, addition of energy to a hydrocarbon feed to "break" the molecules giving acetylene in somewhat low concentration followed by its separation and purification. Differences among these processes are in the energy sources. In thermal cracking, an auxiliary fuel supplies heat to a cracking furnace. In partial oxidation, heat is supplied to a furnace by burning some of the hydrocarbon in the furnace with air or oxygen. In electric discharge, the fuel is passed through an electric arc.

History And Development

Man-made acetylene first was produced in the laboratory of the English chemist, Edmund Davey, in 1836. Some twenty-four years later the French chemist, Berthelot, synthesized it by causing an electric arc to pass between two carbon poles in an atmosphere of hydrogen. He forced the mixture of gases resulting to pass through ammoniacal copper sulphate solution from which acetylene separated as

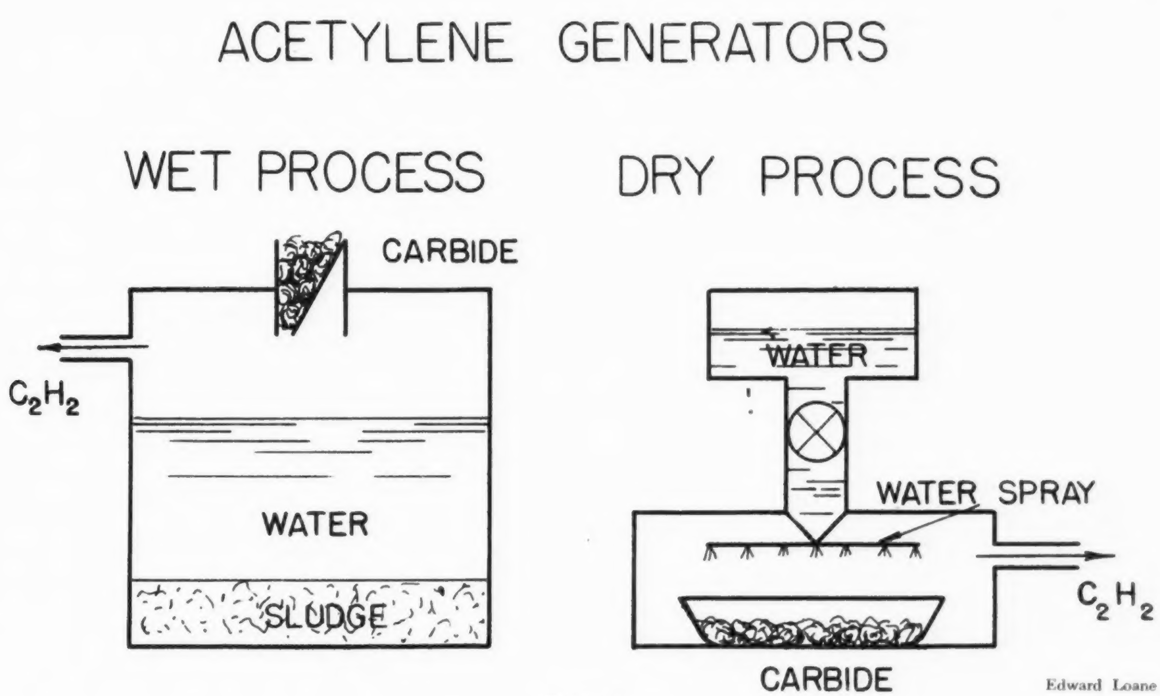


Figure 1

a precipitate of copper acetylide. An examination of this material showed that its formula was C_2H_2.

The next big event in the history of acetylene took place in 1892 in a laboratory in Spray, North Carolina, where a group of technologists were working under T. L. Willson on a process to produce elemental calcium from lime for use in the reduction of aluminum oxide. Their electric furnace yielded a product that although reactive with water was definitely not calcium. The puzzled experimenters sent a sample of the material to North Carolina State University for analysis. The report came back that it was calcium carbide, and the gas it generated when in contact with water was acetylene.

Subsequent to this the first commercial carbide plant in the United States went into operation at Niagara Falls, New York, in April 1896. The plant was under the direction of J. M. Morehead, the son of one of the members of the team that made calcium carbide "by mistake."

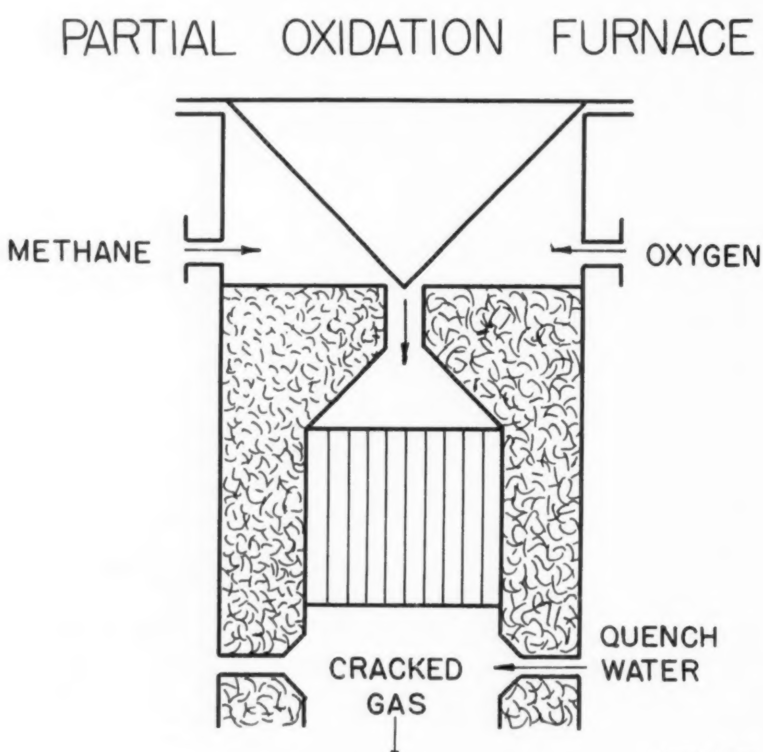
This company, The Acetylene, Light, Heat and Power Company, two years later became The Union Carbide Company. At first, they devoted their energies and money to the development of acetylene as a means of increasing the heating and lighting values of water gas. After several disappointments along this line of endeavor, special burners, heating mantels, and generating units were finally developed for using pure acetylene for cooking and lighting of homes, farms, and factories.

The Prest-O-Lite Company at Indianapolis, Indiana began in 1906 to compress acetylene to 250 psi at seventy degrees Fahrenheit and pump it into cylinders packed with porous material saturated with acetone. This practice naturally evolved into the widespread use of the gas as a fuel for welding and cutting torches and a calcium carbide acetylene industry took form.

There was interest in the use of acetylene as a chemical raw material as far back as 1910, when Germany began to use it as starting material for many commercial syntheses. Four years later, an acetylene based chemical industry was established in this continent by the Canadian Electro Products Company at Shawinigan Falls, Quebec. This company, which later became Shawinigan Chemicals, Ltd., installed commercial processes for the manufacture of acetaldehyde, acetic acid, and acetone and supplied the Allied cause in World War I with sizable quantities of these materials. The famous work of Father Julius A. Nieuwland, of the Catholic University of America and later of Notre Dame University, did much to further an interest in acetylene chemistry in the United States.

In 1914, The Union Carbide Company established a synthetic organic fellowship at Mellon Institute. By 1924, the Carbide and Carbon Chemical Corporation had begun to operate the first semi-commercial acetylene chemicals plant in the United States at Niagara Falls, New York.

Since World War II, two major inventions have been introduced into the acetylene industry and have given more significance to acetylene as a basic raw material for the chemical industry. One is the process for producing acetylene from the relatively cheap raw material, natural gas. The second is the development of so-called "Reppe-Chemistry." This new technique of high pressure synthesis of acetylene, which has been worked out in Germany under the direction of Dr. Reppe, gives acetylene promise of a cheap starting material for the production of various chemicals.



Edward Loane

Figure 2

Calcium Carbide Method

In principle, the manufacture of calcium carbide is very simple and has changed little since it was first developed in 1892. A mixture of lime and carbon is heated in the intense heat of an electric arc between 2,000 and 2,100 degrees Centigrade. The lime is reduced by the carbon according to the equation:

$$CaO + 3C \rightarrow CaC_2 + CO - 111 Kg-Cal.$$

The carbide formed is in the liquid state containing an excess of lime and a large part of the impurities that were present in the raw materials.

Most carbide plants make their own lime, so that it reaches the carbide furnace as fresh as possible, unaffected by moisture and other causes of dust formation. The content of magnesia, sulfur, and phosphorus as impurities is as low as

possible. The size of lime is about 2½ inches or smaller. The coke used has a low ash content. Petroleum coke is the most desirable because of its low ash and high resistivity, but, at present, coke from coal is widely used and constitutes over 90 per cent of the coke used in carbide manufacture today.

The electric furnaces used are usually operated on low voltage (from 75 to 250 volts depending on size) high current (50,000 to 100,000 amperes), and at capacities between 5,000 and 18,000 kilowatts. There is some indication that the furnaces of the future will range in capacity upward to 30,000 kilowatts.

The raw materials are mixed in the ratio of 2,000 pounds of lime to 1,300 pounds of coke and then fed automatically to the furnace. The carbide in a liquid state is tapped through a hole in the side of the furnace either intermittently or continuously and is solidified by cooling twenty-four or forty-eight hours. Normally a product of 80 or 85 per cent purity is produced, although up to 95 per cent calcium carbide has been obtained.

Acetylene Generation from Carbide

Acetylene is easily generated from carbide by reaction with water as shown in the following equation:

$$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2 + \text{heat}$$

The above process is usually carried out at fifteen psi and far below 300 degrees Fahrenheit. Excessive pressure and heat increase the potential explosion danger and decreases the efficiency with the formation of an unwanted by-product. Acetylene yield from carbide is about 0.32 pound (4.5 cubic feet) of acetylene per pound of carbide.

Commercial acetylene generators in the United States are classified into two types depending on the process used. In the wet process (shown in figure one) the carbide is dropped into a large quantity of water at a measured rate. The calcium hydroxide formed is discharged continuously through an inverted U-leg in the form of a lime slurry containing about 90 per cent water. On the other hand, in the dry process (also shown in figure one) water is sprayed onto the carbide in a rotating drum in a pound for pound ratio to the carbide present.

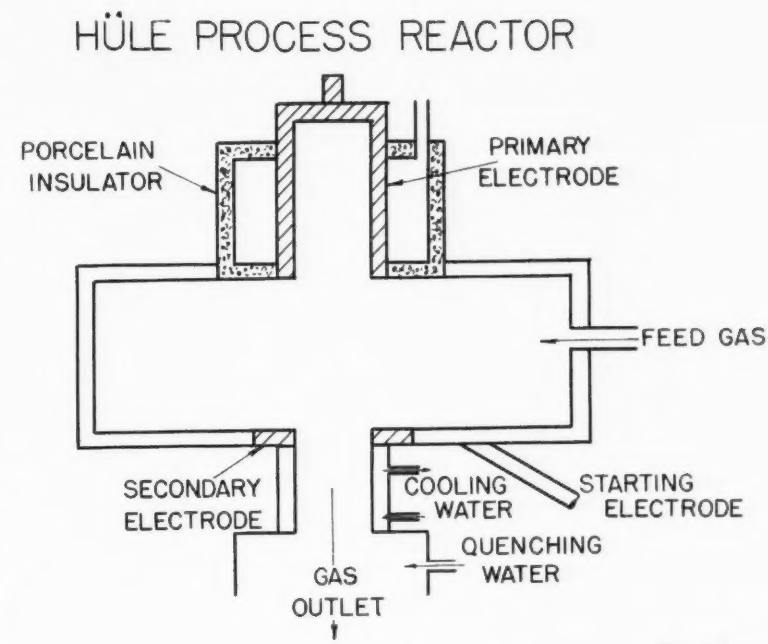


Figure 3

As the heat of reaction (900 Btu per pound of carbide) vaporizes the excess water, the calcium hydroxide formed is dried. This is readily sold or recycled to a carbide furnace with subsequent savings. Careful temperature control must be practiced to prevent acetylene polymerization and decomposition during the reaction. The generated gas containing traces of hydrogen sulfide, ammonia, and phosphine, is purified by scrubbing with water or sulfuric acid.

Partial Oxidation

During World War II, I. G. Farben operated a plant at Oppau, Germany, producing acetylene by partial combustion of methane with oxygen. The yields of acetylene based on this method of partial oxidation of methane are about 32 per cent and the concentration of acetylene in the final gas is about 8.5 or 9 per cent. The reaction:

$$CH_4 + \tfrac{1}{2}O_2 \rightarrow CO + C_2H_2,$$

furnishes the heat. This reaction is actually the key to the commercial success of this process, because the mixture of $CO + H_2$ in the synthesis gas is a valuable feed for other petrochemical operations.

The equipment is comparatively simple, consisting of refractory furnaces, shown in figure two, in which a mixture of methane and oxygen separately preheated to 750 degrees Fahrenheit, is mixed and burned, attaining a temperature of about 2,700 degrees Fahrenheit. Four burners are employed having a combined feed of 140,000 cubic feet of methane and 90,000 cubic feet of oxygen per hour. Approximately 280,000 cubic feet of cracked gas is produced with the following composition: acetylene 8.0 per cent: carbon monoxide 25.0 per cent, carbon dioxide, 4.0 per cent, methane 5.0 per cent, hydrogen 58.0 per cent.

The mixture gas of methane and oxygen are mixed in the Venturi Throat and then burned in the refractory mass containing a plurality of tubular channels.

In operation of the burners, gas velocities are maintained higher than the flame propagation velocity and lower than the extinguishing velocity. Total time of contact from ignition to quenching is less than one-tenth second. The cracked gas after passing through the burners is subjected to quenching with water. The oxygen requirement is about 4.4 pounds per pound of acetylene.

Lately, the Belgian firm of Societe Belge de L'Azote (S.B.A.) has come up with its own version of acetylene manufacture via partial

oxidation of hydrocarbon. The main differences from the process described are their specially designed metal burner, instead of refractory burner, and their use of liquid ammonia as selective solvent in acetylene purification. In the United States, today, several commercial plants employing the partial oxidation process are on stream.

Arc Process

There are two arc processes. The Hüle process which has been developed since World War II in Germany and the Schoch process which has been studied by Dr. E. P. Schoch and his associates at the University of Texas. In the Hüle process, natural gas, primarily methane or coal hydrogenation by-product gases, after purification to remove sulfur, are compressed to twenty pounds absolute and passed through an electric arc. While this process is referred to as an arc process, it is actually a partial thermal decomposition. Contrarily, the Schoch process is more truly an arc process.

The electrical requirements of Hüle's arc for natural gas feed are approximately 10 kilowatt hours per kilogram of impure acetylene. These requirements are greater than those for the carbide process, but since hydrogen and carbon are also obtained, the total cost is reduced. In the operation of the Hüle process, hydrocarbon gases are passed through a bank of arcs, each operating at 7,000 volts, D.C. The typical installation has ten reactor sets, each set consisting of one mercury arc rectifier, for converting alternating current to direct current and two arc-reaction tubes as shown in figure three. One tube is used as a standby unit.

The arc will operate with methane (natural gas) or methane-ethane mixtures (by product from coal hydrocarbon) as feed. The feed to the arc consists of approximately one part of fresh gas and one part recycle gas. Each arc unit handles 70,000 cubic feet of feed which is expanded to 147,000 cubic feet per hour during reaction. The terminal temperature in the reaction tube is about 3,000 degrees Fahreinheit, but reaction gases are immediately quenched to 300 degrees Fahrenheit by a water spray. The primary electrode is jacket cooled. Conversion per pass through the arc is about 50 per cent. For 100 pounds of fresh gas, therefore, forty-five pounds of acetylene, 9.2 pounds of ethylene, 5.3 pounds of carbon black and 2,270 cubic feet of hydrogen are obtained.

The Schoch process is much more interesting for practical application because of its favorable production costs and low capital investment required. The discharge chamber which is shown in figure four is a gas tight box kept at ten to fifteen psi inside pressure. The box contains a rapidly rotating blower wheel that is one electrode of the system and a stationary flat metal shoe which serves as the opposite electrode.

The rotor serves to feed the gas which is introduced into the eye as a thin sheet through the wedge shaped channel formed by the 60 to 70 per cent shoe and the rotor. Since about sixty to seventy per cent of the discharge energy is liberated as sensible heat, the temperature in the chamber is kept below 550 degrees Fahrenheit. Each unit consists of six such chambers, and gases proceed through them in series. This process requires 1.6 pounds of hydrocarbon gas or 2.15 pounds of liquid hydrocarbon to make a pound of acetylene.

When using methane as a feed gas, and a 10 per cent acetylene containing product is formed, about one third of the methane in the feed is cracked during its passage through the system with the balance passing out together with the hydrogen and the other non-hydrocarbon constituents. This off gas, when produced from pure methane, contains 55.5 per cent methane, 44.4 per cent hydrogen and a trace of ethane. Since 1,000 cubic feet of the feed gas (methane) produces about 1,200 cubic feet of off gas of this composition, the total heat units in the latter amount to about 82 per cent of those in the feed gas.

Economics of Using Natural Gas

Many excellent improvements have been made in recent years, and several acetylene plants em-

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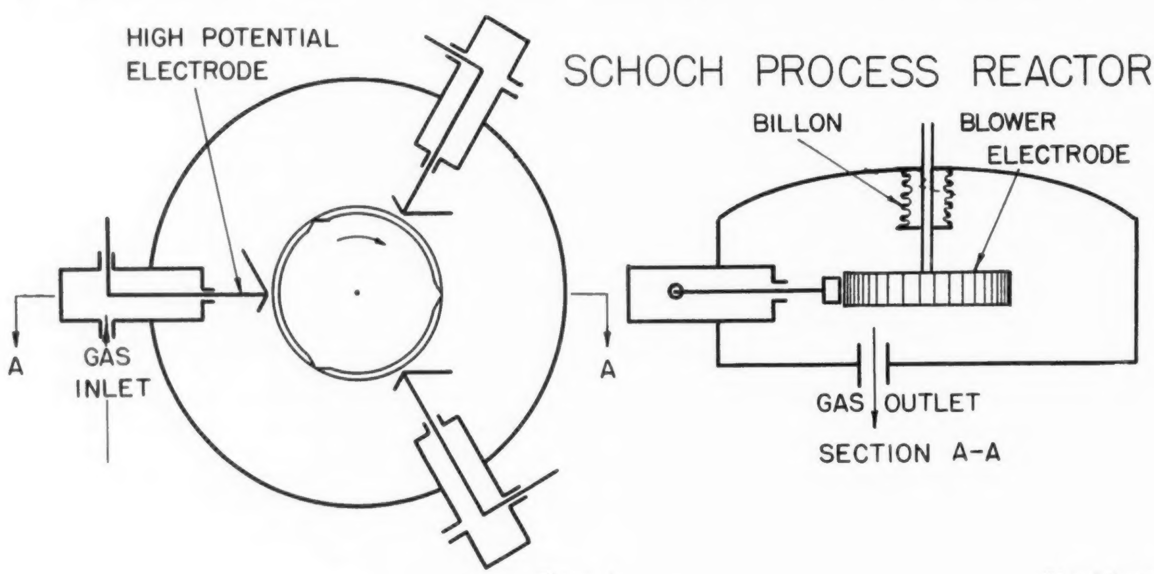


Figure 4

Edward Loane

A Campus-to-Career Case History

"I wanted a job I could grow with—and I've got it"

H. James Cornelius graduated from Swarthmore College in 1954 with a B.S. in Electrical Engineering. He's been "growing" ever since with the Bell Telephone Company of Pennsylvania.

After an initial 44-week inter-departmental training course, Jim was made Facility Engineer in charge of the fast-growing Norristown-Pottstown area. In that capacity, he engineered over half a million dollars' worth of carrier systems and cable facilities between major switching centers in Pennsylvania.

Today, he is one of 50 young engineers from the Bell Telephone Companies chosen to attend a special Operating Engineers Training Program at Bell Laboratories. This 19-month course of study—with full pay—deals with advanced techniques and new concepts in electronics which signal a new era in telephony. It involves both classroom theory and practical laboratory applications.

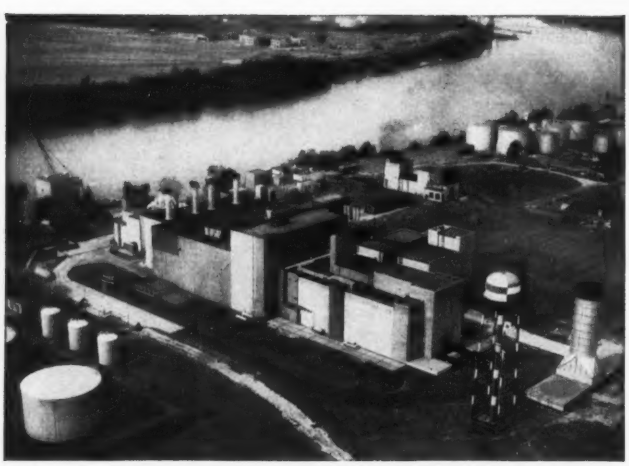
When Jim and his colleagues return to their companies, they'll review major engineering projects. This will assure the best use of equipment for current engineering, as well as for expected new developments in communications.

"I wanted a job I could *grow* with," says Jim, "and I've got it. I can't think of a better place than the telephone company for an engineering graduate to find a promising future."

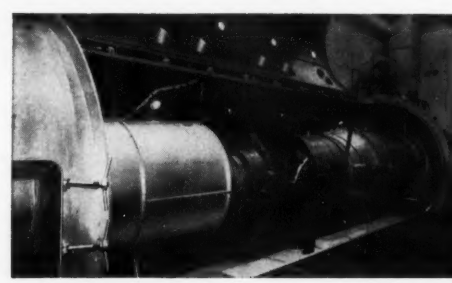
Many young men like Jim Cornelius are finding rewarding careers with the Bell Telephone Companies. Look into opportunities for *you*. Talk with the Bell interviewer when he visits your campus. And read the Bell Telephone booklet on file in your Placement Office.

BELL TELEPHONE COMPANIES

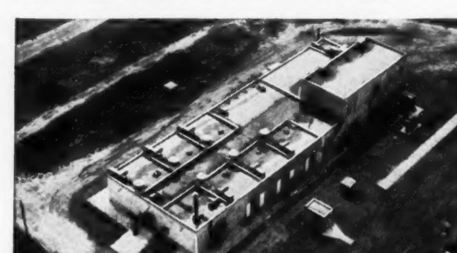
CONNECTICUT



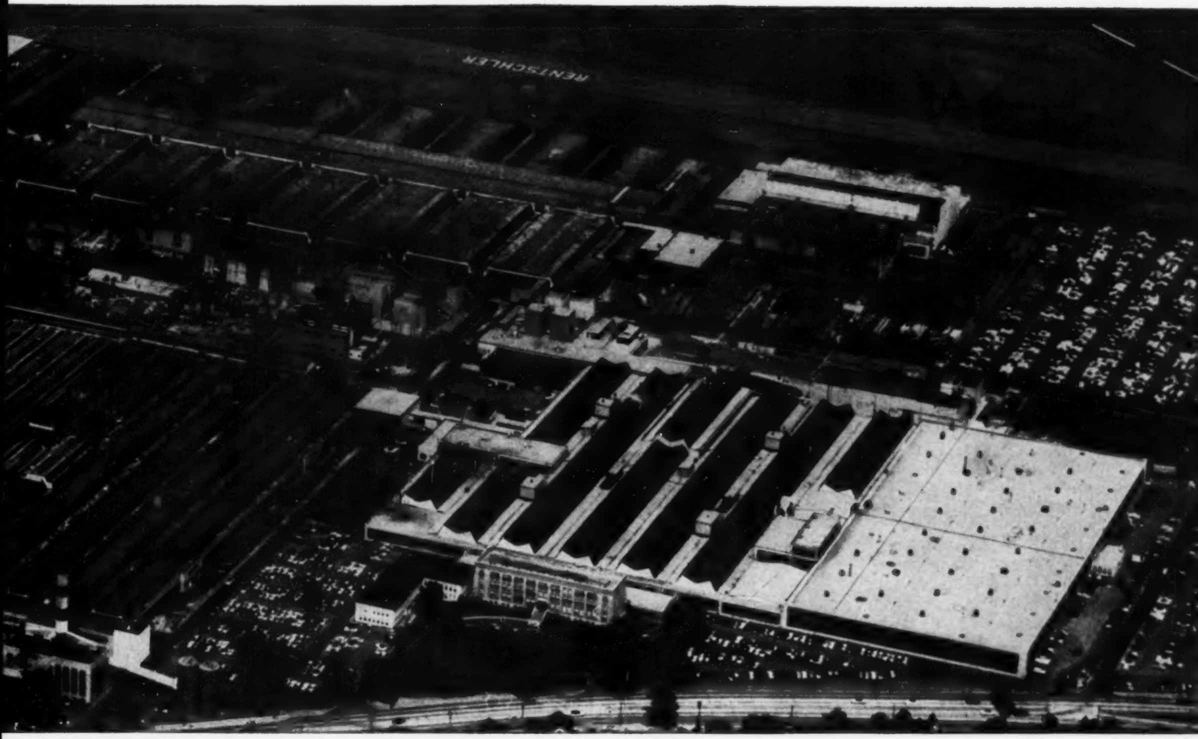
The Willgoos Turbine Engine Test Facility is the world's most extensive privately owned turbine development laboratory. Designed and built specifically to test full-scale experimental engines and components in environments simulating conditions at extreme altitudes and speeds, it is currently undergoing expansions that will greatly increase its capacity for development testing of the most advanced forms of air breathing systems.



In chambers like this at the Willgoos Turbine Engine Test Facility full-scale engines may be tested in environments which simulate conditions from sea level to 100,000 feet. Mach 3 conditions can also be simulated here.



In the new Fuel Systems Laboratory engineers can minutely analyze the effects of extreme environmental conditions on components of fuel systems — conditions such as those encountered in advanced types of flight vehicles operating at high Mach numbers and high altitudes. Fuel for these tests can be supplied at any temperature from $-65°F$ to $+500°F$.



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Operations at Pratt & Whitney Aircraft are essentially those of an engineering and development organization. As such, an engineering atmosphere dominates the work being done, much of which directly involves laboratory experimentation.

In the past three decades, expansion at Pratt & Whitney Aircraft has been almost tenfold. In recent years, greatest emphasis has been on extending engineering facilities to meet the needs of advanced research and development programs in flight propulsion.

Among the Connecticut P & W A facilities are many that are unequaled in the industry. Thus today, Pratt & Whitney Aircraft is better prepared than ever to continue development of the world's best aircraft powerplants . . . to probe the propulsion future . . . to build and test greatly advanced propulsion systems for coming generations of flight vehicles — in whatever form they take.

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For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.

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FIFTY YEARS AGO IN THE ENGINEER

Who comes with Faber sharpened keen,
With profile long and sober mien,
With transit, level, book and tape
And glittering axe to swat the stake?
The Engineer.

Who sets the level, bends his spine,
Squints through the glass along the line
Swings both his arms at rapid rate,
Yells, "Hold that bloomin' rod up straight?"
The Engineer.

Who raves and snorts like one insane,
Jumps in the air and claws his mane,
Whene'er he sees a scraper take
A whack at his most cherished stake?
The Engineer.

Who swears he'll charge an "even ten"
For stakes destroyed by mules and men,
While on all fours he tries in vain
To find the vanished stake again?
The Engineer.

Who saws the air with maddened rage,
And turns with haste the figured page,
And then with patience out of joint,
Ties in another "reference point?"
The Engineer.

Who calls it your "unrivalled gall"
Whene'er you kick for overhaul,
And gives your spine the frigid chill,
Whene'er you spring an "extra bill?"
The Engineer.

Who deals with figures quite profuse,
Then tells you solid rock is loose,
That hard-pan's nothing more than loam?
While gumbo's lighter than sea foam?
The Engineer.

Who, after all, commands your praise,
(In spite of his peculiar ways)
While others harvest all the gains
That spring from his prolific brains?
The Engineer.

Cornell Civil Engineer—February, 1908

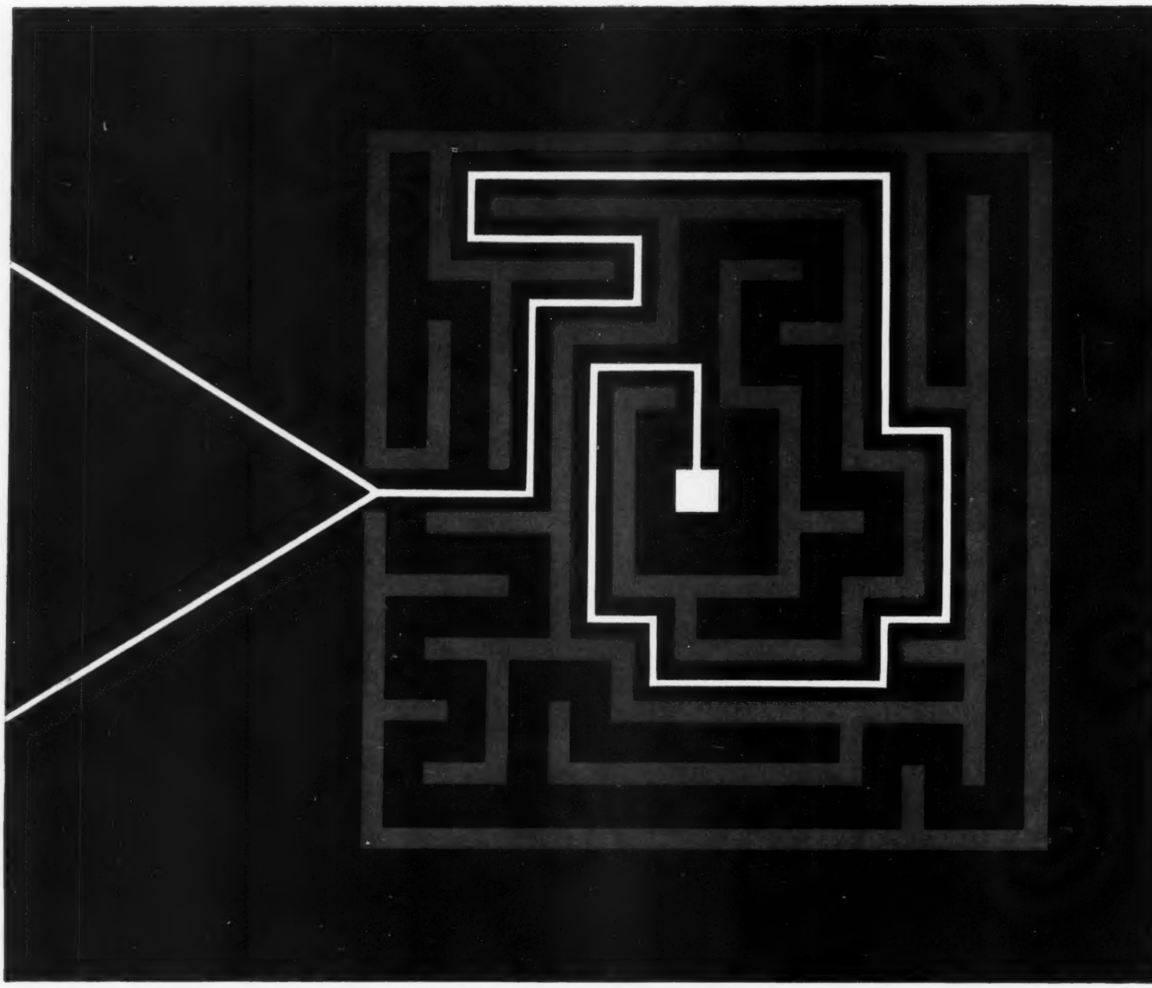
This June we will celebrate the fortieth anniversary of the opening of Cornell University. June the seventeenth is set as Alumni Day of Commencement Week, and on that day there will be a grand reunion of every one of the forty classes which have been graduated since the opening of the University. However, this reunion is not for graduates alone, but for all who have ever matriculated in the University.

At eleven o'clock a short public meeting will be held. Ex-President Andrew D. White will talk about "Recollections of forty years ago." President Schurman will tell about "The University of today," and a response will be made on behalf of the Alumni and former students by Frank H. Hiscock, '75, Judge of the Court of Appeals of the State of New York. At two o'clock everyone will march to the field, where the Alumni-Varsity baseball game will be held. In the evening the Glee Club will give a concert at the Lyceum Theatre.

The class secretary and reunion committee of each class will arrange for class reunions. Professor C. H. Tuck has been appointed chairman of the committee on accommodations, and his committee will endeavor to arrange for all former students desiring to return for Commencement Week, provided that he is notified prior to June 1st as to just what accommodations are desired. It is believed that at least 2000 former students will return for this reunion. Of the total number of graduates, about one-tenth have graduated from the College of Civil Engineering. To keep up the proportion two hundred Civil Engineers will have to return. Make a special effort this year of all years. The College has always been known for its good spirit in all things, and this year true Cornellians all over the country will be trying to return, if possible, to the scene of their many good times and recollections. *Cornell Civil Engineer*—April, 1908

With the exception of a few short vacation trips Dean Haskell spent the summer in Ithaca, superintending repairs, alterations, and improvements to Lincoln Hall, the Fuertes Observatory, and the Hydraulic Laboratory. The Materials Testing Laboratory was enlarged and several of the testing machines moved to new positions with a view to making room for new machines.

The work of placing the new 60-inch sluice-gate in Beebe Dam, begun during the summer of 1907, was completed. The University will now be in position to prevent further silting up of Beebe Lake, and expects to be able to wash out considerable of the material that has already been deposited in the lake. (*The Cornell Civil Engineer*, November, 1908)



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MINING

(Continued from Page 17)

could not be welded or tempered.

The making of malleable iron by decarbonization of cast iron originated sometime in the early sixteenth century. This development, while at first slow in getting started, accounted later on for a revolution in civilization; for now, in addition to the availability of large quantities of cast iron, ductile, malleable iron could be produced in large amounts at a considerable saving of labor and at a greater yield per ton of ore.

With large supplies of cast iron available armies could be equipped with cannon, mortars, and carriages with iron fittings. Princes and kings began stocking cannon in preparation for the impending religious wars. Iron parts for metallurgical equipment and for other machines and tools, in addition, offered a potentially strong market for peacetime. These increased demands for iron could be met only with larger installations. Thus the iron industry was forced to expand. In time iron production was no longer confined to small forges in the side of a hill near the source of ore. Large iron mills were built down in the valleys, especially along the Rhine River. These new units belching forth smoke rang with the sound of large scale metal production. At Styria in what is now Austria the output of iron seems to have quadrupled between the 1460's and the 1530's to an annual production of some 8,000 tons per year. The large scale introduction of cast iron in addition to the decarbonization process can certainly, then, be listed as one of the major achievements of this period.

Copper Silver Liquation

An equally important development during this age was the separation of silver from copper ore by liquation. Prior to this process large deposits of argentiferous copper ore went virtually untouched, because of the lack of an adequate separation method. As native silver deposits dwindled, the activity and prosperity of many mines declined. While, as mentioned in the introduction, many factors were involved in the economic depression of the early fifteenth century, the depletion of silver deposits appears to have been at least a contributing factor; for without a steady supply of this precious metal nobles and large banking houses who owned many mines were limited in their activities. With the introduction of this process, mines were reopened and many new ones were dug.

The adoption of this process in Germany was particularly significent. German silver mines became some of the largest and most productive in Europe. The most famous *Saigerhutten*, or silver processing plants, were in the Erzgebirge at Scheenberg, Annaberg, and Joachimsthal. Several thousand miners migrated to each of these places and with their families swelled settlements into cities the size of Leipzig and other large towns of Southern Germany. Perhaps nowhere else in Europe was there a greater concentration of capital and labor than at these *Saigerhutten*.

The basic principle of the liquation process is based on the fact that if a copper lead alloy containing a large excess of lead is heated in a reducing atmosphere above the melting point of lead but below that of copper the lead will liquate out and carry with it a large percentage of the silver that was present in the copper. The liquation process of that period consisted of six steps. The first step consisted of melting the copper-silver alloy in a tall furnace with lead. When the metals became molten they would flow to the bottom of the furnace and be withdrawn into clay lined copper molds. Upon cooling, the molds were removed leaving cakes of copper-silver-lead alloy weighing between 225 and 370 pounds.

In the next step these cakes were placed in a low rectangular furnace and covered with charcoal to provide maximum reducing conditions. When the furnace was heated to a temperature above the melting point of lead but below that of copper, a lead-silver alloy separated out and ran out the bottom of the furnace at one end.

In a furnace open to the air the spent copper cakes were "dried" with heat to oxidize residual lead. This constituted the third step. The silver-lead alloy was fed to a cupellation furnace, where after lengthy heating, the boiling lead would either oxidize or be absorbed in a special crucible. The fifth step consisted of the purification of copper in a refining furnace. In this furnace strong blasts of air from bellows continually passed over the molten copper oxidizing impurities and producing copper oxide which upon diffusion through the rest of the melt readily parted with its oxygen which was again available for further oxidation of impurities. The last step entailed recovery of silver from the many by-products that had been collected along the way. The results of this process were probably at best a 70 per cent recovery of silver with losses of 9.1 and 16 per cent respectively of copper and lead.

It is estimated that between 1460 and 1530 the silver output in Central Europe increased several times over. From 1526 to 1535 approximately three million ounces of silver were produced per year—a figure not again attained until the 1850's.

The new process swelled the production of copper thus leading to more bronze (an alloy of copper and tin) and brass (an alloy of copper and zinc). The availability of these metals in large quantities permitted the production of bronze cast cannons and brass fittings for smaller firearms in much greater profusion.

The innovations and refinements instituted in the mining and metallurgical industry during the fifteenth and early sixteenth centuries and the apparent enlightened thinking of the men in the industry during this time appears to be the manifestation of the same enlightened curiosity expressed in art, architecture, and exploration that had taken hold in Europe. This period in metallurgy was as the Renaissance—a rebirth and transition to the modern.

It should not be inferred that the developments described above were practiced in all or even a large fraction of the mines and mills of this era. Hand labor and crude methods were still employed even in the most advanced installations, to a great extent along side the newer power driven equipment and processes. However, the trend toward mechanization was at least started.

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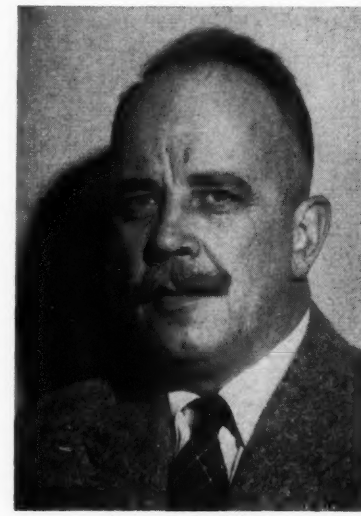


Roscoe H. Fuller

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."

THE PRESIDENT'S LETTER—

Having been a member of the Cornell faculty for twenty-five years and its Dean of Engineering since 1937, Dean Hollister is to retire from active administration this June. His stature and accomplishments in the fields of Engineering, Education, Industry, and Government Affairs have been such as to reflect great credit upon the Institution we all love so well. Through his efforts the reputation of Cornell Engineering has continued to grow, to the advantage of Cornell Engineers everywhere.

Perhaps Dean Hollister's crowning achievement has been the re-location of the Engineering College on the South quadrangle and the erection and equipping of a complete new set of buildings to house its expanding facilities and it is expected that by the date of the Dean's retirement sufficient money will have been pledged through the Engineering Development Fund to complete the job.

It is the purpose of your Society to do honor to this distinguished Cornellian on the eve of his retirement; a purpose in which it is felt that every Engineering alumnus will want to join. We therefore extend a sincere invitation to all interested persons and their ladies to attend:

THE HOLLISTER RECOGNITION DINNER
HOTEL PLAZA, NEW YORK
APRIL 14, 1959

Reception: 6:00 P.M.—Terrace Room

Dinner: 7:00 P.M.—Grand Ball Room

Tickets may be obtained by mailing your check for $12.00 per person to the Hollister Dinner Committee, 107 East 48th Street, New York 17, New York. As space may be limited, it would be wise to do so as soon as possible.

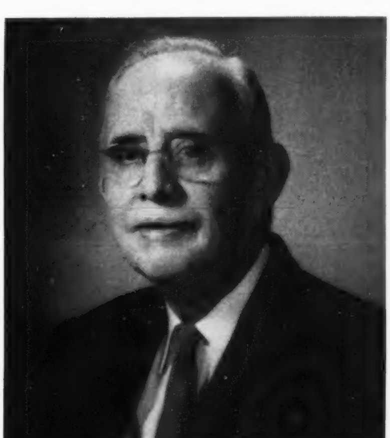
ROSCOE H. FULLER

ALUMNI ENGINEERS

Theodore J. Bliss, B.E.E. '46, has been promoted to engineering and service manager of the Boston District for Westinghouse Corp.

Glenn B. Woodruff, C.E. '10, was one of three engineers commissioned in 1950 to explore the engineering aspects of bridging the Mackinac Straits in Michigan. In 1953, he was named associate consulting engineer for the project and was responsible for the foundation design. The result is the now famous Mackinac Bridge.

Mr. Woodruff's bridge building experience covers forty years and includes some of the outstanding bridges in the country. He was design engineer of the San Francisco-Oakland Bay Bridge and had important roles in many others, such as the Rip Van Winkle and Mid-Hudson Bridges in New York State, Huey Long Bridge in New Orleans, and the Ambassador Bridge in Detroit. In addition to bridges, he has been, since 1946, structural consultant for Bechtel Corporation. In 1953, he had a large part in laying two twenty-inch oil pipe lines in the bed of the Straits of Mackinac at depths up to 238 feet to transport crude oil from Alberta to Eastern refineries as part of the Lakehead Extension of the interprovincial system. Lately, he has carried on studies for the Rotterdam-Rhine pipeline now under construction.

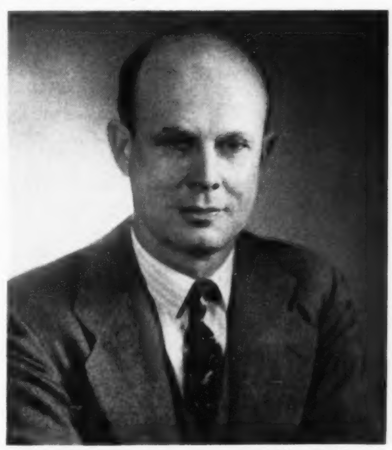


Alumni News

Glenn B. Woodruff

Merton D. Meeker Jr., B.E.E. '52, has been promoted by General Electric from design engineer to a job concerned with the training and placement of personnel in GE's technical marketing program.

Henry C. Boschen, M.E. '28, is vice-president in charge of overseas activities for Raymond International, Inc., operating overseas as a general contractor and undertaking all types of construction. Mr. Boschen is also a member of the ASCE, a director of the Colombian-American Chamber of Commerce, and a trustee of the American College of Girls in Istanbul, Turkey.



Alumni News

Henry C. Boschen

William Littlewood, M.E. '20, vice-president for equipment research of American Airlines, has just been named 1958 recipient of the Daniel Guggenheim Medal. Mr. Littlewood was cited for "leadership and continuous personal participation over a quarter of a century in developing the equipment and operating techniques of air transport." Earlier this year Mr. Littlewood was made an Honorary Fellow of the Institute of Aeronautical Sciences, the highest honor the Institute can bestow.

Marvin M. Wilkinson, M.E. '32, was named executive vice-president of the Ohio Citizens Trust Company, Toledo, Ohio. After graduating from Cornell, Mr. Wilkinson joined the Toledo Shipbuilding Company. He remained with that firm for thirteen years, and was vice-president and general manager upon liquidation of the company in 1945. At that time, he joined the Ohio Citizens Trust Company as secretary. He was elected vice-president in 1945.

Alumni News

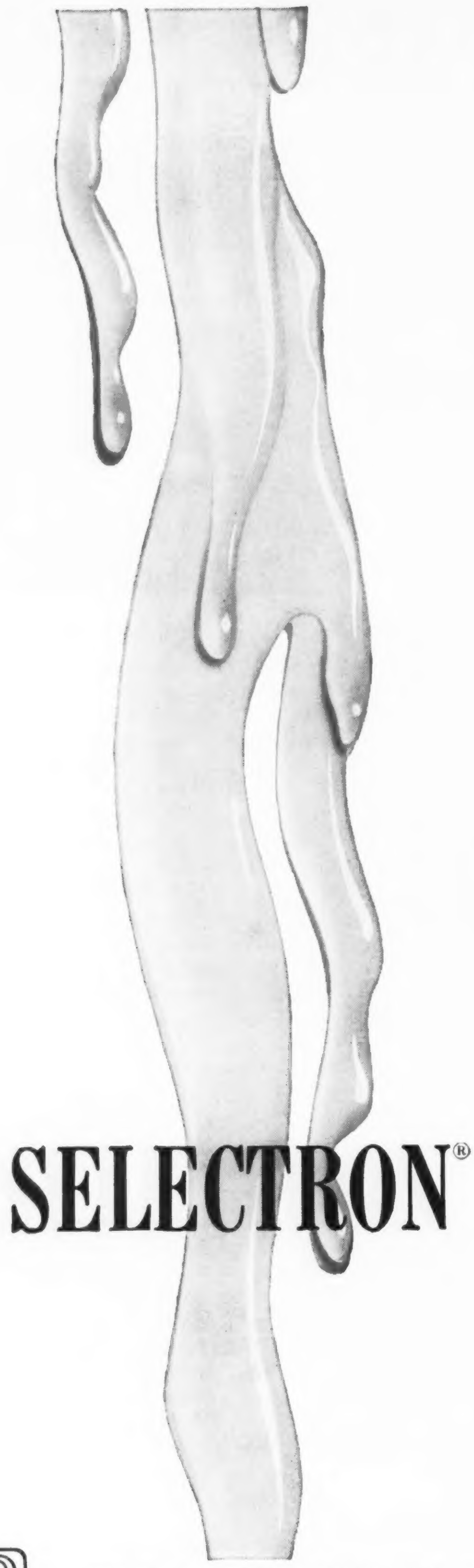
Marvin M. Wilkinson

Mr. Wilkinson is past chairman of the Easter Seal Fund Campaign and presently is a board member of the Council of Social Agencies of Toledo. He is president of the Achievement Foundation of Toledo and a member of the board of directors of the Toledo Community Chest.

Wilmer A. Dehuff, C.E. '10, has retired after thirty-seven years as principal of Baltimore Polytechnic Institute.

Mr. Dehuff worked as an inspector for the Maryland State Roads Commission for two years following his graduation from Cornell, then joined the faculty of Baltimore Polytechnic Institute as head of the engineering department, in 1912. For five summers he worked as an engineer for the Baltimore and Ohio Railroad. From 1919 to 1921 he was associate professor at Johns Hopkins University.

Charles C. Jamison III, B.M.E. '46, has just become section engineer for the weapons systems planning group of Westinghouse Electric Corporation, Drexel Hill, Pa.



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And Selectron is just one of a long roster of products developed from the many facets of PPG research. Every day, the scientists and engineers at PPG work toward developing new products and new uses for already established products to benefit our living in countless ways. Right now, long range research is being directed toward finding new applications for polyester resins, toward screening and improving original ideas and molding them into practical applications.

If you want a career with challenging opportunities and a real and rewarding future, find out about your place at Pittsburgh Plate Glass Company. Write to: Manager of College Relations, Pittsburgh Plate Glass Company, One Gateway Center, Pittsburgh 22, Pa.

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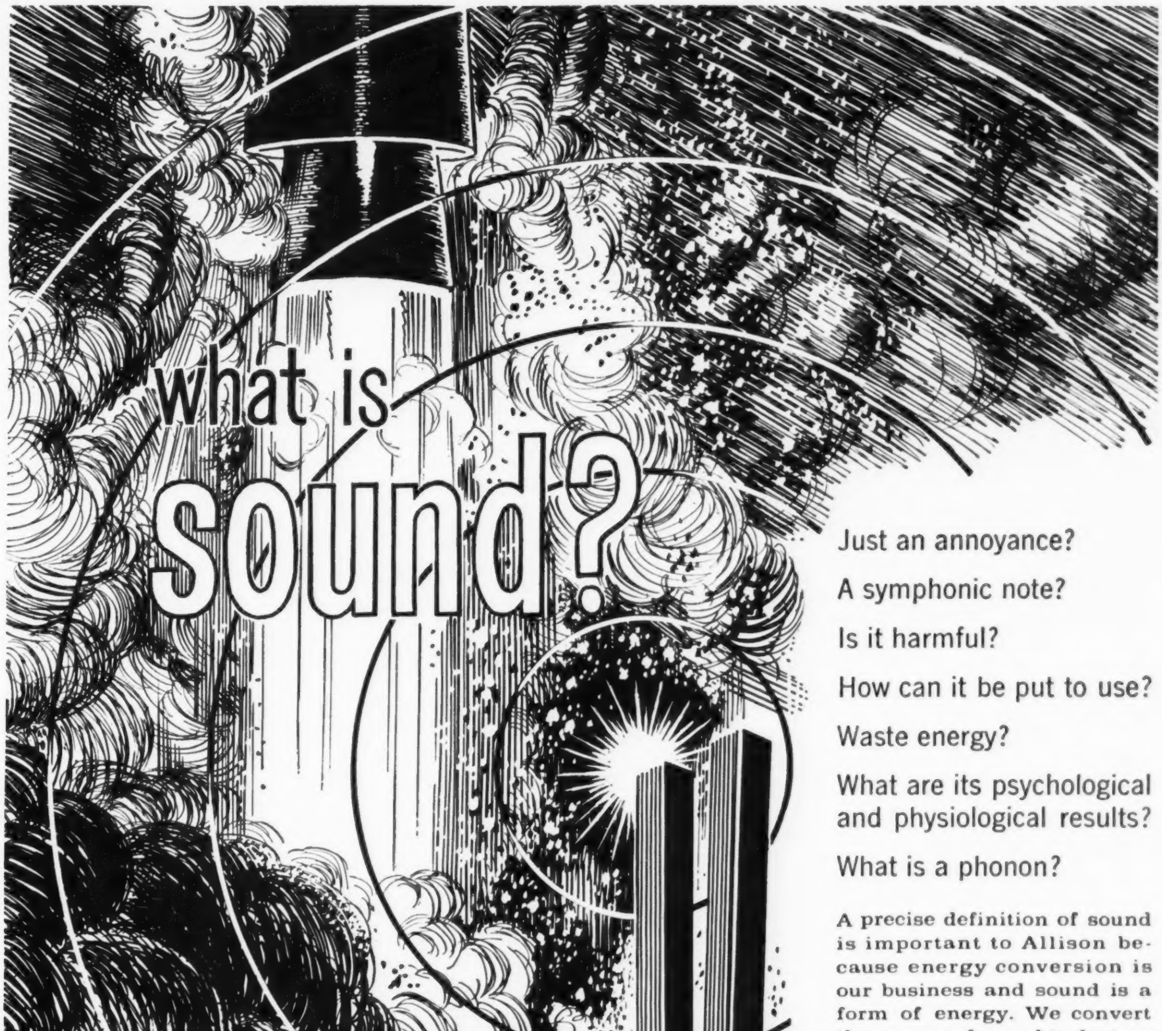

Just an annoyance?

A symphonic note?

Is it harmful?

How can it be put to use?

Waste energy?

What are its psychological and physiological results?

What is a phonon?

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COLLEGE NEWS

Edited by J. L. Schoenthaler, ME '61

CE BUILDING NAMED IN HONOR OF DEAN HOLLISTER

The new civil engineering building now under construction at Cornell University has been named Hollister Hall by the Cornell Board of Trustees in honor of Dean S. C. Hollister, who is scheduled to retire as Dean of the College of Engineering at the end of the present academic year.

The new building which will cost $2,000,000, is being given to Cornell by Spencer T. Olin, a Trustee of the University, in memory of his father, the late Franklin W. Olin, who was also a Trustee of Cornell.

It is hoped that Hollister Hall will be sufficiently near completion to permit dedication ceremonies before Dean Hollister retires. He has been a moving force behind the new engineering quadrangle at Cornell, and the building bearing his name will be the seventh on the quadrangle to be completed during the present decade.

Professor Hollister initiated the plan for an engineering quadrangle shortly after he became dean in 1937, and four years later the first building was completed. This building, for chemical and metallurgical engineering, was the gift of Franklin W. Olin, in memory of his son, Franklin W. Olin, Jr., who received the M.E. degree from Cornell in 1912, and who died in 1921.

The second World War delayed further development of the engineering quadrangle until 1952. Since then five more buildings have been completed and are now in use. One other building, for aeronautical engineering, is now under construction, in addition to Hollister Hall.

Dean Hollister has served a number of federal agencies as a technical advisor, and currently is chairman of a group of technical advisors to the U.S. House of Representatives Merchant Marine and Fisheries Committee, which is studying the advisability of enlarging the Panama Canal and other canals. He has been a leader in science education in the United States, and served as President of the American Society for Engineering Education, in 1951 and 1952.

He received the B.S. degree in engineering in 1916, and the C.E. in 1932 from the University of Wisconsin. He was the recipient of the Wasson Research Medal in 1928 and the Lamme Medal in 1952.

Spencer T. Olin, the donor of Hollister Hall, is director and member of the executive and finance committees of the Olin Mathieson Chemical Company of Alton, Ill. He was the first vice president of the Olin Industries, from 1945 until the merger of that company with the Mathieson Chemical Corporation in 1954. He began his association with Olin Industries in 1921, following his graduation from Cornell with a degree in mechanical engineering.

He is a resident of East Alton, Ill., and a brother of John M. Olin of the same community, who was graduated from Cornell in 1913, and who is also a trustee of the university.

The new civil engineering building, donated by Spencer T. Olin, will be named Hollister Hall in honor of the retiring dean.

CORNELL GETS GRANT FOR STUDY OF JETS

Research into the problems of jet aircraft engines will be carried on at Cornell University under a five year grant of $45,000 from Therm-Electric Meters Co. of Ithaca.

The grant, which became effective January 1, makes $750 a month available to Cornell to maintain a graduate assistantship plus supporting faculty and technician help. Therm-Electric Meters Co. has also agreed to build any necessary experimental equipment. The Cornell research will augment similar work being done at the Therm Advanced Research Division.

The immediate problem under study at the Graduate School of Aeronautical Engineering, where the Cornell research will be centered, is concerned with lift augmentation by jet flaps and similar devices. This means an airplane's lifting power can be improved by blowing a jet of air out the trailing edge of the wing, increasing the circulation of air around the wing. The Cornell researchers will try to find new and more effective ways of doing this.

Cornell's research in this field is being carried out under the direction of Professor W. R. Sears of the Cornell Graduate School of Aeronautical Engineering. Working under Professor Sears, Assistant Professor Donald Ordway has been studying the performance of the blades of jet flaps in a cascade wind tunnel, a device in which blades are tested under conditions similar to those of an actual jet engine.

ARE WE SUPERIOR OR INFERIOR TO OUR MACHINE RIVALS?

Human beings use processes which can not, in the light of man's present knowledge, be duplicated by any machine.

This was the opinion of a majority of Cornell professors questioned about the possibility that machines can do anything human beings can do.

The interviews were occasioned by a recent international conference on "The Mechanization of Thought Processes" at Britain's National Physical Laboratory. Selected for questioning were scientists whose fields were related to the theory and design of computing devices, and to psychology. The scientists were asked to comment on the statement, widely accepted by the conference representatives, that "Whatever a human being can do, an appropriate machine can do, too."

Dr. Frank Rosenblatt, responsible for designing the proposed computing device, Perceptron, does not think machines can replicate any human action. "There remain a number of performances which people are capable of which depend solely on experiences people have as members of human society," he says. "This includes recognition of other people's emotional states, for example. No machine that has yet been developed can have the kinds of experiences which would enable it to recognize love or hate in someone else. However, machines can certainly solve any mathematical problem a human being can solve."

Psychology Prof. Robert B. MacLeod takes a somewhat different view of the question. He says: "I consider this an interesting problem. In theory I see no reason why we can not replicate any process of the human organism. However, I am not optimistic about its being done in the near future. This doesn't mean we shouldn't continue to try."

Assistant Prof. Julian Hochberg, now carrying on experiments in perception, has this to say: "It is notable that such statements about machine capabilities come from people who have not made intensive studies of what human beings can do. Such comments come from persons whose knowledge of what human beings are capable of is filtered through their attention to machines. No one yet knows all the things people can do; so how could anyone be certain a machine could duplicate any human action?"

Pete Gaalaas

The Sage Chapel organ is being used as the basis of research to improve its tone qualities.

A neurologist, Prof. Marcus Singer, is also skeptical of machine capabilities. "In comparison with the capabilities of the brain, present-day machines, although precise and brilliant in their complexity, are concerned with the trivial. They do not, for example, have the ability to dwell upon situations past and future which do not exist in reality. I can appreciate the tremendous enthusiasm and optimism reflected in such statements about machine potential, because the analysis of certain machines has contributed greatly to our understanding of brain function. It seems probable to me that many of the functions of the mind will some day be replicated in these machines. However, such statements do not reflect our present knowledge of the capacities of machines and are therefore unrealistic."

Professor Robert J. Walker, Chairman of the Cornell University mathematics department, says: "I see no justification for such an assumption. There are certain aspects of human beings which are mechanical and certain other aspects for which no mechanical basis is evident. These include, for example, the experience of beauty, love, and religious feeling."

ORGAN TO BE SUBJECT OF EE RESEARCH

Prof. Clyde Ingalls of the EE School has initiated a research program concerned with the improvement of the organ. He has proposed to use this program to broaden students' views toward the applicability of their work. The music department, psychology department, and the EE school will work together on this project thereby exposing those involved to fields and areas they might not ordinarily encounter.

There are disadvantages to a pipe organ, no matter how good the instrument is. Temperatures affect the pitch. Dirt enters easily into the opening. There is difficulty in adjusting a whole rack of pipes to give uniform quality. It is impossible to change the volume with varying key pressure.

The work course laid out consists of obtaining photographs of different wave forms from the Sage Chapel organ and attempting to generate similar ones. Prof. Ingalls' opinion is that the transient form of the sound wave bears more influence on the human ear than presently realized. These transient forms will be varied and tested on the human ear for psychological reactions. There are also possibil-

ities of using computer elements to change stops for different sounds thereby enabling the musician to have more freedom for playing.

The major merit of this program is the anticipated student realization of the inter-relation of his field with others.

CAL STARTS ACTIVITIES FOR NEW WIND TUNNEL

Cornell Aeronautical Laboratory revealed that it had extended its wind tunnel testing capabilities to include tests at hypersonic speeds. The Laboratory's hypersonic tunnel, formerly used for basic research, has been made available to outside companies for testing aircraft and missile designs at speeds up to twenty times the speed of sound.

Three major aircraft companies, Boeing, McDonnell and North American, have already contracted with CAL for testing in this flight region.

Tests have been made on a model of North American X-15 at speeds in excess of Mach 5 (five times the speed of sound). The X-15 is the free world's first hypersonic research airplane for exploring the approaches to manned space flight.

Tests to determine the aerodynamic heating characteristics and heat transfer rates to structural components have been performed. Depending upon test conditions, temperatures produced in CAL's hypersonic tunnel may exceed 9,000° Fahrenheit.

Heat transfer studies on a model also have been conducted for McDonnell Aircraft Corp. and on a design for the Boeing Airplane Co. Details were not given.

The Laboratory has been active in the development of hypersonic shock tunnels since 1950. It operated the first such facility in 1953. CAL also pioneered the development of instruments capable of recording temperature, force, and pressure in such high-temperature, high-Mach number tunnels.

The state of the art in this field has progressed to a point where complete simulation of flight conditions over a considerable range of hypersonic speeds and altitudes is now possible, CAL reported.

In addition to its present tunnel, with an eleven by fifteen inch test section, the Laboratory is now designing a new facility with a test section of three square feet.

SECRETS OF LIFE TO BE STUDIED UNDER NSF GRANT

The secrets of life itself are being studied at Cornell University under the recently awarded National Science Foundation research grants.

A grant of $55,400 has been made to Prof. Richard H. Barnes, Dean of the Graduate School of Nutrition, to study the value of tiny plants in the body which help create substances essential to good health. Professor Barnes will try to discover how microscopic plants in the large intestine affect the nutrition of dogs, rats, and people.

"The large intestine serves as a sort of fermentation vat where microorganisms act on the food that reaches the area," Professor Barnes says. "Practically nothing is known of the contribution of these bacteria to the nutrition of animals besides cows, sheep, and other ruminants. Our ultimate aim is to find out how much of the material produced by these microorganisms is used by human beings."

A grant of $49,200 to study photosynthesis—the mechanism by which carbon dioxide is taken from the air and converted into sugar in plants—has been awarded to Associate Prof. Martin Gibbs of the Department of Biochemistry and Nutrition.

"Photosynthesis is the most important process on which life as we know it depends," Professor Gibbs says. "All creatures either eat green plants or eat creatures that live on green plants, and photosynthesis is a key process in vegetable organisms."

Professor Gibbs says the process itself is still a mystery. "Somehow—nobody knows exactly how—sunlight converts a compound with one carbon atom into a compound with six carbon atoms. We're interested in learning more about the steps involved in the transformation," the scientist says.

ChE SALARY SURVEY INDICATES VALUE OF FIVE YEAR PROGRAM

Should a young man study engineering for four years, or five, before starting his professional career?

This has been argued in educational circles ever since Cornell University established the first five-year curriculum in engineering in the country more than two decades ago.

Defenders of the four-year curriculum have claimed that their graduates have been able to start their professional work earlier and so have gained financially over students who have delayed doing so for a year.

Proponents of the five-year program at Cornell and at other institutions which have since adopted their own five-year programs have claimed that the five-year men have been able to command higher starting salaries and have been able to progress faster, despite their year lag in entering professional work.

An article entitled "Cornell's Five Year Engineers Are in the Chips," in a recent issue of Chemical Engineering Magazine raised this often debated question, and then gave the nod to the five-year program. The magazine, analyzing a survey of the salaries being made by Cornell men who completed five-year programs in Chemical Engineering last June, declares that "this year's (1958) graduates are being hired at rates that are more than those being paid to men who have been out of school for a year."

The 1958 Chemical Engineering graduates are averaging $6,396 annually, the magazine reports, and the median is $6,420. "These figures are for 29 men who supplied information. In a few instances, 1958 grads did not report salary information, and a considerable number entered the Armed Services and graduate schools."

The article noted that 1953 Chemical Engineering graduates of Cornell are averaging $7,920 annually, and that 74 per cent of the class reported their earnings. Chemical Engineering graduates of ten years ago are averaging $12,144, according to returns from 74 per cent of the class.

"Chemical engineers, after completing five years at Cornell, are doing quite well," concludes the magazine. "They start high and show fast progress in earning power."

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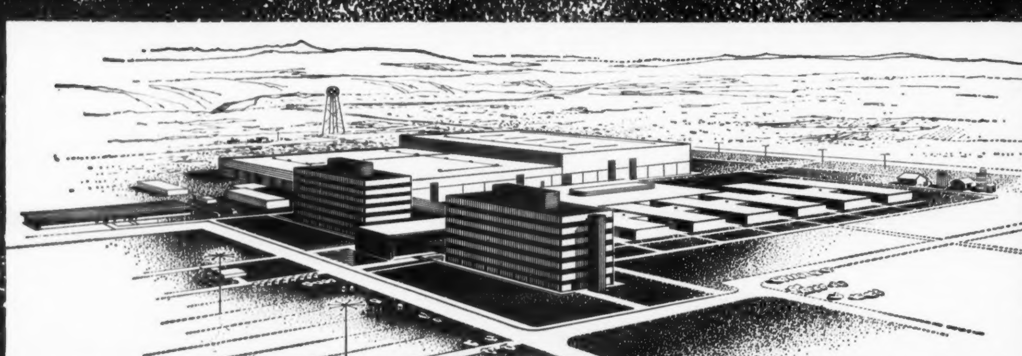

First Prize Tau Beta Pi Essay

A CALL TO LEADERSHIP

by Marc Fishzohn, ME '60

We Americans live in a wonderful, fascinating land. The precepts upon which our government is based and the ideals which our society embraces would earn the admiration and the joy of the philosophers of the ages. Democracy . . . the equality of opportunity, the freedom of the will, the dignity of the individual . . . democracy is the most precious institution ever created by men. And in America democracy is the cradle of high aspiration, of inspiring greatness and of glowing promise for a better tomorrow.

We have long equated America and democracy; from our birth as a nation we have considered America and the principles set forth in the Declaration of Independence and the Constitution as one and inseparable. And since the turn of the century other countries have seen in America the hope and promise for the future and have looked to us for leadership in a fast-moving, chaotic, strife-ridden world. Twice in the last fifty years we have accepted the responsibilities of this leadership and have risen to the insidious challenge of totalitarianism and tyranny. Each time the struggle was bitter, long and bloody. Each time we contributed generously of our wealth, men and spirit. And each time the forces of democracy triumphed, thus preserving for a while longer the institutions which we cherish.

Since World War II we have become deeply involved in yet another conflict: a "cold war" with a great rival power. The very nature of this rival power, based upon precepts and organized by methods which are irreconcilably incompatible with our own, ensures that the present struggle be a deadly one. Democracy is again being challenged, but this time the challenger is ponderous, thorough, and calculating. Possessing immense resources, outstanding talent, and a powerful drive, he has embarked upon a fervent campaign to extend his influence and control throughout the world.

The cold war is being fought upon economic and ideological grounds. Although the fearsome possibility of nuclear warfare is still with us, the present struggle is centered upon the battle for men's minds. To a totalitarian victor comes the control over new lands and peoples; to a democratic victor comes the opportunity to advance freedom and peace. In this world of rapid transportation and interdependent nations, the implications of Free World boundaries shrinking before the encroachments of a totalitarian society merit serious consideration. Indeed, we are being faced with a threat to our very existence, and the magnitude and finality of this threat is without parallel in history.

We have won some of the battles of the cold war and have at times demonstrated the kind of leadership which carries great nations and great causes through crises. But when the cold war is viewed from the perspective of December 1958, a plain, hard fact is observed: we are not faring well. Communism has scored alarming successes in Southeast Asia, has subversively exploited the dynamic nationalism of the Mideast. We note with sorrow that when China went communist, one-quarter of mankind went with it. These examples can easily be multiplied, but the deeply disturbing conclusion which strikes us is that the prospects for the future are not pleasant.

Why haven't we fared well? Can't America rise to the momentous challenge which has confronted her? Compared to our great rival, why are we, as Walter Lippman puts it, ". . . a declining power, destined—if we do not meet the challenge—to know the frustrations and insecurity of nations which have achieved and have then lost their sense of mission and of greatness?"

The crux of the problem lies in our leadership. To meet the challenge successfully, America needs dynamic, confident leadership. To plot the course to a free, peaceful world and to guide her unerringly through the currents of international politics, America must have leaders of a new breed. This is the breed of men with fine educational depth and intellectual insight, with an eye toward bold, new visions and a capacity for well-defined, determined action. These must be the leaders of our nation.

It is a source of pride and satisfaction to us in college to see in many of our classmates the qualities of leadership noted above. At first impression, it creates a sense of confidence and security, for we know that these are the potential leaders America should have. But upon looking further a great paradox of our age becomes apparent: although these potential leaders graduate from our universities and colleges seemingly well-equipped to fulfill their potentialities, they rarely assume the positions of great leadership. Somewhere, somehow they become sidetracked, and as a result America lacks the leadership she needs.

It behooves us, as members of Tau Beta Pi, to inspect the situation as it pertains to the engineering profession. The technological nature of our society is well known

to us. Never in the course of history has man had such machines and power at his fingertips; at the same time never has he been confronted with such vast systems and technical intricacies. The immense scope of modern society staggers the imagination and defies the comprehension of most men. The very enormity and complexity of our society makes it one extremely difficult to understand and direct.

Today the gap in mutual understanding between men of technical and non-technical fields is rapidly growing wider; yet the crucial necessity for this understanding is becoming increasingly more urgent. The politician frequently makes decisions in areas about which he admittedly knows virtually nothing. On the other hand, the engineer and scientist frequently become so absorbed in their endeavors that they are completely unconcerned, even unaware of the overall significance of their work. This gap must be bridged. Advice and guidance concerning technical areas must be forthcoming from men who have an understanding in these areas which far transcends that which sociologists and politicians could possibly possess.

Who is to advise and guide? Who is to grasp the technical problems, see the social implications, intelligently interrelate the two and provide the necessary leadership? Who in our technological society is uniquely capable of combining a knowledge of science and engineering with a deep awareness of the problems of today's world—to furnish the guidance that is now lacking? The answer is obvious: it is the engineer.

Our most pressing problem is to determine why the engineer hasn't been assuming the role of leadership that awaits him. We see that there are two major reasons: the lack of concern over the problems of our society, and the lack of awareness regarding the opportunities for leadership.

That a great many of us demonstrate a remarkable lack of concern over the problems of today's world can easily be witnessed. Rather than becoming involved with difficult situations outside of our own family and job, we are content to sit back and "leave it to the other fellow." Furthermore, it

seems that the "ism" of the college man today is professionalism. One will say, "I'm a businessman; I'll leave the tasks of government up to the politicians"; another, "I'm too absorbed in this missile project to worry about what happens in Washington."

Now it is true that in this age of specialization the student engineer must pursue an intensive course of study which will endow him with technical proficiency in the field to which he will devote most of his time in later years. But it is not true that this discharges him from the heavy moral obligation that he be an aware and informed citizen, interested and concerned in the affairs of the country. As students, therefore, we must not be content with gaining only engineering knowledge and technical competence; rather, we must endeavor to understand our world through a study of the humanities—of history, literature and sociology—and then build upon this foundation our edifice of engineering acumen. John Stuart Mill wrote, "Men are men before they are lawyers or physicians or manufacturers; and if you make them capable and sensible men they will make themselves capable and sensible lawyers and physicians."

In part, the lack of concern stems from the lack of awareness regarding the opportunities for leadership. Because we may frequently feel that the evolution of events lies outside of our influence and that powerful forces would inhibit any efforts on our part to initiate improvement, we tend to exhibit this lack of concern. This attitude does justice neither to our capabilities nor to our democratic society. Indeed, a brief glance reveals many of the opportunities for action which surround us.

First of all, as informed and concerned citizens we can discuss current events intelligently in our own communities and vote wisely. Secondly, as engineers we can understand the significance of many technical works which are beyond the grasp of the layman; thus, we can explain the implications of our amazing technical advances to our fellow citizens. Thirdly, as members of Tau Beta Pi and other professional societies we can deliberate in convention upon pertinent issues of national importance; subsequently we can utilize the prestige and power of these societies to effectively advise our government and fellow citizens of our opinions. Fourthly, as leaders in business, research, engineering and finance, we can set an influential example through our own concern and actions, thereby arousing enthusiastic, important support for worthy undertakings and campaigns. And finally, as the leaders of a world already with us we can recognize our duty toward our country and devote at least some measure of our time to public service.

All of the above opportunities are a call to leadership. Far from being a time of stagnation and oppressive conformity, our age contains the greatest challenges ever known. Sputnik need not be a symbol of decline; indeed, it is a stimulus to an awakening. The future can and shall be ours, but we must be willing to assume the obligations of great leadership. We, the leaders, bear the responsibility of our generation and of those to come. Men about to inherit this responsibility must rise to the level of their time.

ACETYLENE PRODUCTION

(Continued from Page 28)

ploying natural gas in the arc or partial oxidation process have been on stream or under construction. It is expected that acetylene from hydrocarbons will amount to 1,000 million pounds in 1970. Generally speaking, acetylene manufacture from natural gas has become cheaper and more feasible year by year, corresponding to its technical development and its increasing demand by the petro-chemical industry.

The primary defect of all these processes employing natural gas is the resulting low acetylene concentration in the product stream. Because of this, a larger capital investment is necessary in purification and concentration systems. Adding to this, because acetylene is non-transportable, plants must be built very close to large consumers of acetylene. Therefore, much consideration should be paid to the acetylene consuming plant and its end product, thus giving many complicated restrictions on acetylene plant cost, size, and location.

While the use of natural gas in various processes for the production of acetylene is increasing, the old stand-by, the carbide method, will remain the major process for some time to come, as it has for sixty years. This will be so, partly because of the efficiency of the process and partly because of the large investment in plants.

Next Month in

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- his professional engineering work
- his work on engineering education
- his paleontological studies

TECHNIBRIEFS

Edited by R. A. Wolf, EP '62

SOLAR SAIL SUGGESTED FOR SPACESHIP PROPULSION

A Westinghouse research scientist, Dr. T. C. Tsu, has announced that a large sail may be the answer to space flight propulsion problems. A huge sail made of aluminum foil or light plastic would use the sun's energy to propel space craft.

It has long been known that light exerts a small but definite pressure on a body when it shines on it. According to Dr. Tsu's calculations a sail 1600 feet in diameter would be sufficient to propel a payload of one thousand pounds.

In operation, the ship would be shot up from the earth's surface by a conventional rocket to an altitude of about one thousand miles where it would circle the earth in a satellite orbit. The sail would then be opened to receive the sun's energy. This energy would cause the orbit to become larger and larger until the ship would escape the earth's gravitational grip to become a solar satellite spiraling around the sun.

While this process of breaking free from the earth's gravitation might take several weeks, the orbit-to-orbit travel time via solar sailboat would be less than half the time required for a conventional rocket to reach orbital position around Mars.

Although a rocket would become a solar satellite much faster than a space ship using a solar sail, the rocket would have to go into an elliptic trajectory after burnout and would travel to the far side of the sun before intersecting the orbit of Mars. The solar sail, on the other hand, would be constantly under power. It would therefore be able to travel on a different trajectory and could take a short cut.

The craft would be much more readily controllable than a conventional space ship. The sail could be turned or extra sails could be hoisted to accelerate it in any direction. In a rocket-propelled space ship, an error in navigation could cause it to miss an orbit and wander out into space without fuel. A solar sail, however, would never run out of fuel and could always get back to earth.

Because of the fact that no extensive research would be necessary to perfect the sail, it could probably be developed in much less time than a satisfactory rocket device.

NEW PLASMA TORCH MELTS ULTRA-HARD MATERIALS

A radical new method for fabricating shapes and applying coatings that will withstand temperatures above 5000 degrees Fahren-

Westinghouse

Dr. T. C. Tsu, aerodynamicist at the Westinghouse Research Laboratories, examines a model of a solar-propelled space ship which may provide man's best transportation to nearby planets. Dr. Tsu's calculations indicate that the sail, made of aluminum foil or very thin, lightweight plastic, would be cheaper and lighter than any other means of propulsion now proposed.

Linde Company

A nozzle liner for a rocket engine is made of tough tungsten with the new Linde Plasma Arc Torch. The torch, which harnesses temperatures up to 30,000 degrees Fahrenheit, fabricates shapes like this by applying successive coatings on a spinning mandrel until the desired thickness is reached. The mandrel is then dissolved out, leaving the part complete.

heit has been announced by the Linde Company, Division of Union Carbide Corporation.

The Plasma Arc Torch, a small device less than two inches in diameter, can generate temperatures of up to 30,000 degrees Fahrenheit—the highest controlled temperatures ever used in industry—without itself being consumed in the heat. It makes possible the shaping of parts made of zirconium, molybdenum, tungsten, and tantalum, materials which are virtually unworkable by any conventional methods.

In the new process, the substance to be worked is prepared in either wire or powder form and passed through an intense arc that is struck inside the torch. Due to the enormous heat of the arc, even an ultra-hard metal passing through it is converted into a fluid or plastic state. High velocity inert gases then carry the particles out of the torch and deposit them on a spinning mandrel. Successive coatings of the material are sprayed on the mandrel in this way until the desired thickness is obtained. The mandrel is then dissolved out leaving the finished product.

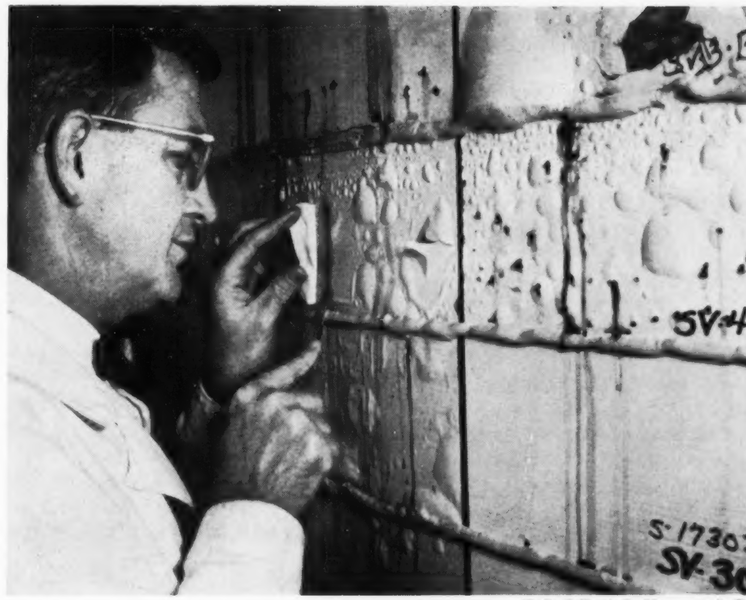
Although the Plasma Torch is a new development in the fabrication field, it has been used for some time in advanced research. Set up as a wind tunnel tool, the plasma arc can simulate speeds up to Mach 20 and reproduce the conditions which a missile encounters when it re-enters the earth's atmosphere at terrific speeds.

An experimental High Current DC Arc Torch is now in operation at a Linde Company laboratory to explore problems involved in using electric power above 10,000 amperes. This will result in concentrations of power equivalent to three megawatts per square inch which correspond to putting the total output of the largest electric generator into an area of six inches square.

NEW ACRYLIC HOUSE PAINT ELIMINATES BLISTERING

A new house paint that is entirely different from the oil-type coatings used for centuries and at least 50 per cent more durable has been announced by the Dupont Company.

The new house paint, an acrylic emulsion, when used in combination with a special primer over bare wood, is capable of unprecedented protection against blistering.



E. I. duPont de Nemours & Co.

The "Blister House" in the Dupont paint laboratory allows study of moisture blistering. Exterior walls are kept cold while interior is kept warm and humid. This simulates the chief cause of blistering where the warm air inside a house becomes laden with moisture and migrates to the outside through the walls, causing blisters in ordinary paint. The new Dupont house paint, however, allows vapors to breathe through, eliminating blistering.

Blistering, which has long been the most serious problem in house paint, results when moisture migrating out through the walls from the interior of a wood building is trapped by old-style paint films which cannot "breathe." The combination of the new blister-resistant primer and acrylic house paint is engineered to allow moisture vapor to breathe through while preventing water penetration from the outside. The new paint's "breathing" characteristic also permits its application over damp surfaces without blistering.

'RED-HOT' MOTOR DEVELOPED FOR HIGH-SPEED AIRCRAFT

An electric motor which operates continuously over extended periods of time while completely immersed in temperatures of nearly 1000 degrees Fahrenheit has been developed by scientists of the Westinghouse Electric Corporation. The motor is believed to be the first to have operated in the thousand-degree range for any appreciable length of time without some form of artificial cooling. It has run for more than one hundred hours while sealed inside an oven at 950 degrees Fahrenheit.

The motor was designed to test, in as severe as practical application as possible, the performance of a new system of electrical insulation for motors, transformers, relays, and other electrical equipment required to operate at very high temperatures, such as those encountered in the supersonic flight of jet planes, missiles, rockets, and other high-speed aircraft.

The insulation is different from any now in use, being composed entirely of inorganic materials. It is well known that many inorganic materials such as sand and clay can withstand much higher temperatures than most organic materials. A problem arose in finding such an inorganic material which was also flexible enough to be used for wire. An inorganic material was found to satisfy this requirement and it operates at temperatures well above the stability of any known organic material.

A test motor with windings using this special insulation was equipped with high-temperature bearings. Copper wires could not be used because the metal oxidizes quickly at high temperatures and becomes useless as a conductor. Pure silver was found to work

satisfactorily at high temperature and was used in the motor. Heating strips were placed around the motor and the machine was covered with asbestos. The motor then ran at full speed for hundreds of hours at almost 1000 degrees Fahrenheit. The intense heat, however, did not harm the new insulation and its thermal life at 1000 degrees is apparently almost infinite.

MODULATED BRAKE DEVICE MAKES TRUCKS SAFER

General Motors Corporation engineers are using the leveling mechanisms of the air suspension systems now being installed in trucks to adjust the braking effort in the truck in accordance with the loading conditions. This system will allow a truck tractor to stop almost as quickly as a passenger car.

Heretofore, the division of braking effort between front and rear wheels has been set for one particular loading condition. For instance, the brakes on a certain truck might be set for ideal performance with a weight of 18,000 pounds on the rear wheels and 11,000 on the front. However, when the tractor is travelling without a trailer, it has only 3000 pounds on the rear wheels and the deceleration which could be attained without the rear wheels sliding would be about one-sixth that possible with perfect adjustment.

On an air-suspension tractor, the leveling valves always maintain normal standing height regardless of load by increasing air pressure within the air bellows as the load increases. On the new trucks, the same leveling valve arrangement also controls the air pressure for the brakes. Thus, the brake pressure is varied in proportion with the load and the distribution of braking effort is always perfect.

LARGE QUARTZ CRYSTALS GROWN ARTIFICIALLY

Quartz crystals are widely used in electronics for filters, oscillators, and frequency standards. Lately, there has been much interest in producing quartz crystals artificially because of the increasing difficulty of obtaining large crystals of natural quartz and because of generally unstable market conditions. Quartz suitable for use in communication devices comes mainly from Brazil where its mining is carried out on an essentially free lance basis. An apparent depletion of larger natural quartz crystals has caused critical shortages at times. During World War II it was necessary to develop and use other piezoelectric materials, notably ethylenediamine tartrate as quartz substitutes in sonar and communication devices.

Recently, details of pilot plant production of synthetic quartz crystals for telephone communication purposes were revealed by Bell Telephone Company engineers. Large crystals are now being grown in limited quantities at the Western Electric plant at Andover, Massachusetts.

In the hydrothermal process used to produce the crystals, a long narrow autoclave mounted vertically is filled with an alkaline solution, usually sodium peroxide. Small pieces of readily available natural quartz are then placed in the bottom of the vessel to provide the nutrient. Seed plates cut from either natural quartz or previously grown crystals are hung from a rack in the upper section of the vessel. After sealing, the autoclave is heated to the required temperature and maintained under a constant temperature differential from bottom to top for the requisite processing time.

The nutrient dissolves in the hotter lower region and is carried by convection currents to the cooler upper region where the lower temperature leads to a supersaturated condition in the nutrient solution and the dissolved quartz redeposits onto the seed plates in single crystal form.

At Western Electric, lab equipment has been scaled up for use in the pilot plant so that crystals five to six inches in length are being produced. The production of synthetic crystals not only makes a greater quantity of large crystals available but it also allows the production of crystals of more useful shape and with fewer imperfections.

LAMP PRODUCES NEGATIVE IONS TO AID HEALTH

Scientists of the lamp division of the Westinghouse Electric Corporation are experimenting with ultraviolet lamps which will produce sizable quantities of negative air ions. The experimentation, which has been in progress for about two years, has been spurred on by evidence that minute electrically charged particles in the air have a noticeable hygienic effect.

Scientific investigation in recent years has revealed that air containing positive ions, invariably brings about an increase in mild health discomforts. These mild discomforts may take the form of fatigue, dizziness, headache, asthma, or sinusitis. On the other hand, scientists believe that negative ions help to relieve these mild disturbances. Researchers say that tests on negative ions have shown that people or animals exposed to these ions experience a marked decrease in annoying headaches, sinus attacks, and hay fever.

Westinghouse scientists stated that for many years they had known that Sterilamp ultraviolet tubes gave off ions. These lamps, however, which have been used in hospitals, schoolrooms, and air conditioning systems, were not believed to have any curative medical effects. In light of recent proof that negative ions do have curative effects, Westinghouse is conducting extensive tests on the ultraviolet tubes with the view of incorporating them in home air conditioners and heating systems.

Although air ions can be produced by radioactive materials, X-rays, and high voltage as in the Precipitron, Westinghouse feels that the Sterilamp presently represents the simplest and most advantageous method.

BEGINNINGS OF TELESCOPE

(Continued from Page 24)

the original instrument are introduced. In order to enable aircraft to fly higher and faster, scientists developed the jet engine to replace the reciprocating engine; in order for some governments to wave a bigger stick, the fusion bomb joined the fission bomb; and so it was with the telescope. An ideal way to obtain magnification without chromatic aberration is to prevent the light from passing through glass. The only way that this is possible is to reflect the light from

a perfectly curved surface of the correct conic section. It was in this way that the reflecting telescope that is so familiar today was introduced.

There were several men who attempted to construct reflecting telescopes but who failed because of inadequate techniques for grinding the spherical mirrors necessary. The first man to actually build a workable reflecting telescope was Sir Isaac Newton.

Newton (1643-1727) was very familiar with the long-focus telescope of his day. He spent much time trying to formulate a theory to explain chromatic aberration and a method to compensate for it. The long focal lengths of these telescopes removed most of the spherical aberration but the chromatic aberration was still a serious problem. It must have been very disconcerting for a seventeenth century astronomer to look through his glass at an object and not be able to decide which of the variety of colors present was the true color, if the true color was present at all.

This was the problem that Newton was trying to resolve. Unfortunately, Newton arrived at the wrong conclusion, even after making many experiments. Whether this was Newton's fault or not, is a question that can never be resolved, but the experimental measurements he made on refraction and dispersion seem to have been made entirely too hastily and were, perhaps for this reason, woefully inaccurate.

The conclusion he reached, that all media have the same dispersive power, prevented the development of the achromatic refractor for a good many years. This unfortunate conclusion would indicate that the chromatic aberration in one lens cannot be corrected by the addition of another lens of a different type glass, since the dispersion of light in all types of glass was, according to Newton, the same. Consequently, Newton then gave up his work on correcting the aberrations of the refractor and began work on a reflector.

Newton's reflector, in its most simple form, consisted of a spherical primary mirror and a flat secondary mirror, plus the necessary eyepiece. The secondary mirror

was so inclined as to re-reflect the light from the spherical primary ninety degrees into the eyepiece in the side of the tube. Instead of focusing the image by moving the eyepiece as is done today, Newton focused by moving the primary mirror either up or down the tube.

Newton made his first reflector in 1668 but kept it secret for three years. After many tests with his first reflector, Newton claimed that he got extremely good definition, but he also complained that the image was rather dark, probably because of the poor reflecting power of the metal he used for the mirror. This mirror metal, an alloy of copper and arsenic, had a silvery appearance. Newton, who was fascinated by alchemy, thought the metal to be silver.

In 1671 Newton made a second reflector which he sent to the Royal Society of London. The members of the Royal Society were so impressed with the telescope and its operation that they immediately made him a member.

Although Newton's reflector was extremely popular among scientists and fascinated astronomers both on the continent and in Great Britain, it was soon all but abandoned because of the old and familiar difficulty of polishing a true surface of revolution. It was to be thirty years before John Hadley produced an astronomically acceptable Newtonian reflector. The fact still remains, however, that Newton built a workable reflecting telescope and succeeded where all others who had tried to build reflectors had failed.

Without the "flash of genius" that prompted Galileo to use the telescope astronomically and without the improvements of the astronomers and artisans named above and countless others not mentioned, our concept of the universe today would be quite limited. The telescope helped immeasurably to prove the Aristotelian concept of the universe wrong and to elevate the Copernican cosmology to its rightful place in science. The popularity of amateur astronomy today is common knowledge, but without the efforts, discoveries, and mistakes made by men of the telescope in the early seventeenth century, astronomy as we know it today would not exist.

CORNELL EXPLORES

(Continued from Page 21)

ground and transmission lines should probably not exceed 60 degrees Kelvin.

The recent break through in the field of parametric amplifiers has completely changed the noise contribution of the receiver front end in the 200-600 megacycles per second range. Using either semi-conductor diodes or the newly developed Zenith Parametric Amplifier Tube, noise temperatures of 100-125 degrees Kelvin have been achieved. Delivery of such receivers is guaranteed well within the required time.

An antenna whose aperture dimensions are of the order of 1,000 feet has to be designed to operate at a frequency of 400 megacycles per second. The antenna should point in a direction that is vertical or not far from vertical. The antenna should be capable of swinging several degrees on either side of its normal position and the design be such that the wobble of the beam, due to vibration of the structure in the wind, is less than the beam width.

The most obvious antenna to consider is a paraboloid with its aperture plane horizontal, fed from a horn on a high tower. The top of the tower would have to be steady enough to keep the beam reasonably stationary, and at the same time the position of the horn would have to be capable of displacement so as to swing the beam through the required angle. We therefore consider a parabolic dish 1,000 feet in diameter operating at a wave length of about 2.5 feet. The wave length divided by 2π is 5 inches. The tolerance of the paraboloid should be appreciably smaller than this. A figure of 2 inches has been selected as reasonable. The diameter of the dish is about 400 wave lengths and the beam-width about $\frac{1}{6}$ degree. A reasonable f/d ratio would be ½, and the tower height would then be 500 feet; it is clear therefore, that the tower height required is within reasonable limits.

In order to increase the beam swinging ability, keeping the reflector fixed, we are considering a spherical reflector as an alternate to the paraboloid. If one solves the problem of feeding the sphere (correcting for spherical aberration) then the symmetry of the sphere permits beam swinging in principle over nearly a hemisphere. The spherical reflector we are considering has a radius of curvature of 870 feet, and an aperture of 1,000 foot diameter. The feed is a line source approximately 100 feet long located 335 to 435 feet above the reflector. To swing the beam one keeps the feed on a radius of the spherical reflector. To swing 20 degrees the feed is moved some 150 feet. (See Figure 1) As tentatively planned some of the energy from the feed will spill outside the reflector when the beam is swung. We expect to accept this loss for the present.

The Location

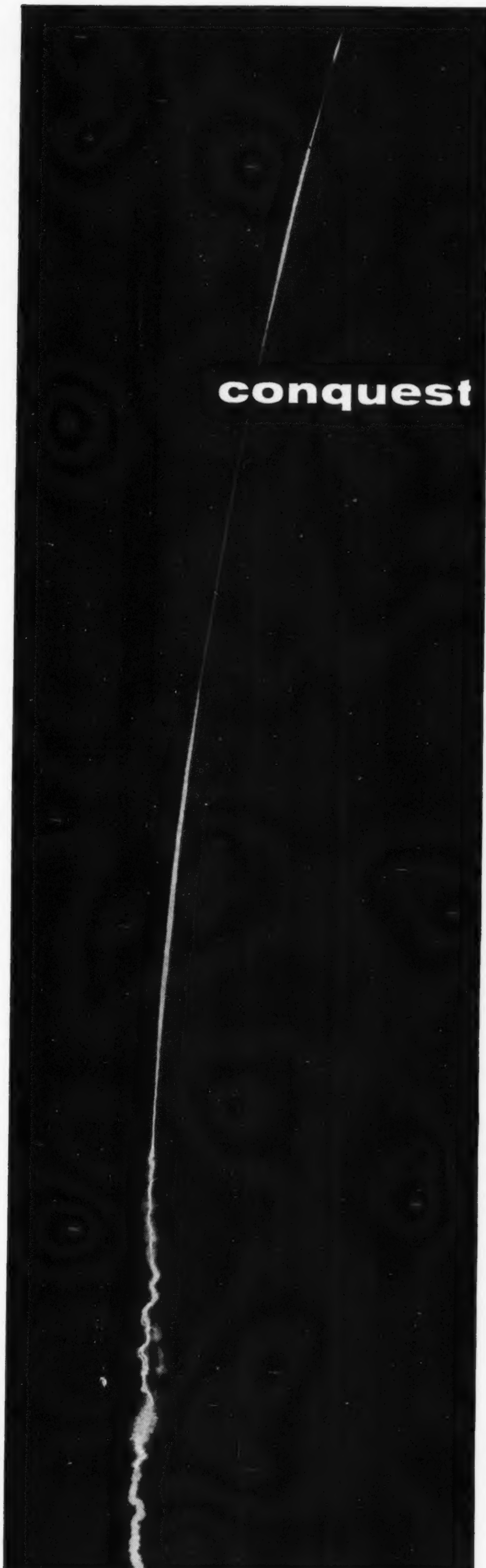
The University of Puerto Rico has been very helpful to date in site surveys. Because of their interest in the problems to be studied with the radar, it is likely that the facility will be developed and operated with their assistance and cooperation.

As described earlier, a site in the tropics is required in order to "see" the planets. A site in Puerto Rico is appropriate because of the natural formations that can be economically adapted to a large antenna. This particular site is well adapted to a paraboloid of 1,000 foot aperture (and f/d ratio of 0.6). The site for the alternate (spherical) antenna is somewhat larger (diameter about 1,500 feet at the top) and deeper (425 feet compared to 100 feet for the site pictured).

The Status

Preliminary designs are complete for the transmitter, the receiving system, the paraboloid reflector and feed support, the spherical reflector and movable feed support.

The work at Cornell is being performed by Professors H. G. Booker, M. H. Cohen, W. E. Gordon, and B. Nichols in the School of Electrical Engineering, and W. McGuire, R. E. Mason, and G. Winter in the School of Civil Engineering. Donald Belcher of Belcher Associates has been responsible for the site surveys.



STRESS *and* STRAIN . . .

To: Engineering Department
Subject: How to become a successful engineer
Copies to: All engineers and big shots

A. Walk fast whether you are going anyplace or not.

B. Always talk loudly, especially over the phone.

C. Disregard anyone who walks up to your desk.

D. When talking with anyone, observe the following rules:

1. Act as if they are wasting your valuable time.
2. Interrupt them often.
3. Always make them repeat everything they say with a sharp "What's that?"
4. Leaf through papers while they are talking as if you were trying to do something else.
5. Never admit you are wrong.
6. Never admit anyone else is right.
7. If smoking, always direct your smoke at your visitor's face.
8. Pay no attention to what your visitor has to say.
9. At the end of the conversation, tell him he shouldn't have bothered you and refer him to someone else.
10. When he leaves, swear violently. Be sure to call him a damned fool. This impresses the secretary.
11. Last and most important, always frown and scowl. Never give anyone a pleasant word. Try your damnedest to confuse everyone you come in contact with, as this leads them to believe they're wrong since they cannot possibly understand you.

° ° °

A clergyman and a truck driver found themselves in an automobile smashup. The truck driver told the minister what he thought of him in profane terms. When he paused for breath, it was the clergyman's turn.

"You know, my good man, that I cannot indulge in your kind of language, but this much I will tell you; I hope when you go home tonight, your mother runs out from under the porch and bites you."

° ° °

A young man in a cocktail lounge saw a blonde sitting at a table nearby and was struck by her extraordinary beauty. In fact, he decided he had never seen such a gorgeous girl. And, almost before he realized what he was doing, he got up, went over to her and asked her to dance. She consented and soon he found she was not only beautiful, but she danced divinely.

When the music stopped, he sat with her and they had a drink. To his amazement, she turned out to be a brilliant conversationalist. And he thought to himself, "here at last is *the* woman." Unable to contain himself any longer, he asked if he might take her home. She smiled and said, "yes."

When the taxi stopped, it was in front of one of New York's most elegant apartment hotels, and the young man pinched himself to see if he were not dreaming—a beautiful, brilliant, amiable girl, and rich, too.

He walked on air beside her as they proceeded down the richly carpeted hallway. She put her gold key in the lock, opened the door and they went into her apartment. When she snapped on the light, the young man stared. There, in the center of the room, lay a dead horse.

Noticing his gasp of amazement, the girl spoke: "I didn't say I was neat, did I?"

° ° °

Two guys I know decided to go hunting one morning.

"I've got the perfect setup," the first one said. "I'll bring all the guns and such, and you bring all the provisions."

"Fine," said the second guy. And when they met the next morning the first guy was heavily laden with guns, shells, baskets and suchlike. The second guy was carrying a loaf of bread and four bottles of whiskey.

The first guy blew his stack. "Look what happens when I leave the provisions to you!" he stormed. "A loaf of bread and four bottles of whiskey! What are we going to do with all that bread?"

° ° °

Marriage is like a poker game. It starts with a pair; he shows a diamond; she shows a flush, and they end up with a full house.

° ° °

A Kansas preacher at the close of his sermon discovered one of his deacons asleep. He said, "We will now have a few moments of prayer. Deacon Brown, will you open?" Deacon Brown roused a bit and replied, "Open! Hell, I just dealt."

° ° °

Professor interrupted during important lecture by sneeze.

"Who sneezed?"

No answer.

Prof. "There will be a 4 hour exam tomorrow."

No reply.

Prof. "I guarantee to flunk half the class."

From back of room, "I did it sir."

Prof. "Gesundheit."

° ° °

One day during a war, a tall, strong, handsome Roman soldier broke into a house where he found two luscious maidens and their matronly nurse.

Chuckling with glee, he roared, "Prepare thyselves for a conquest, my pretties."

The lovely girls fell on their knees and pleaded with him, "Do with us as thou wilt, O Roman, but spare our faithful old nurse."

"Shut thy mouth," snapped the nurse. "War is war."

° ° °

Do you know what the little stream said as the elephant sat down in it?

"Well, I'll be damned!"

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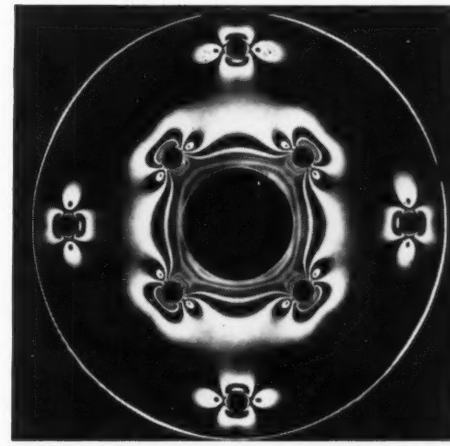

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Interview with General Electric's Earl G. Abbott Manager—Sales Training

Advancement in a Large Company: How it Works

Where do you find better advancement opportunities—in a large company or a small one? To help you, the college student, resolve that problem, Mr. Abbott answers the following questions concerning advancement opportunities in engineering, manufacturing and technical marketing at General Electric.

Q. In a large Company such as General Electric, how can you assure that every man deserving of recognition will get it? Don't some capable people become lost?

A. No, they don't. And it's because of the way G.E. has been organized. By decentralizing into more than a hundred smaller operating departments, we've been able to pinpoint both authority and responsibility. Our products are engineered, manufactured and marketed by many departments comparable to small companies. Since each is completely responsible for its success and profitability, each individual within the department has a defined share of that responsibility. Therefore, outstanding performance is readily recognized.

Q. If that's the case, are opportunities for advancement limited to openings within the department?

A. Not at all. That's one of the advantages of our decentralized organization. It creates small operations that individuals can "get their arms around", and still reserves and enhances the inherent advantages of a large company. Widely diverse opportunities and promotions are available on a Company-wide basis.

Q. But how does a department find the best man, Company-wide?

A. We've developed personnel registers to assure that the best qualified men for the job are not overlooked. The registers contain complete appraisals of professional employees. They enable a manager to make a thorough and objective search of the entire General Electric Company and come up with the man best qualified for the job.

Q. How do advancement opportunities for technical graduates stack-up with those of other graduates?

A. Very well. General Electric is recognized as a Company with outstanding technical skills and facilities. One out of every thirteen employees is a scientist or engineer. And approximately 50 per cent of our Department General Managers have technical backgrounds.

Q. How about speed of advancement? Is G.E. a "young man's Company"?

A. Definitely. A majority of all supervisors, managers and outstanding individual contributors working in the engineering function are below the age of forty. We believe that a job should be one for which you are qualified, but above all it should be one that challenges your ability. As you master one job we feel that consideration should be given to moving you to a position of greater responsibility. This is working, for in the professional field, one out of four of our people are in positions of greater responsibility today than they were a year ago.

Q. Some men want to remain in a specialized technical job rather than go into managerial work. How does this affect their advancement?

A. At G.E. there are many paths which lead to higher positions of recognition and prestige. Every man is essentially free to select the course which best fits both his abilities and interests. Furthermore, he may modify that course if his interests change as his career progresses. Along any of these paths he may advance within the Company to very high levels of recognition and salary.

Q. What aids to advancement does General Electric provide?

A. We believe that it's just sound business policy to provide a stimulating climate for personal development. As the individual develops, through his own efforts, the Company benefits from his contributions. General Electric has done much to provide the right kind of opportunity for its employees. Outstanding college graduates are given graduate study aid through the G-E Honors Program and Tuition Refund Program. Technical graduates entering the Engineering, Manufacturing, or Technical Marketing Programs start with on-the-job training and related study as preparation for more responsible positions. Throughout their G-E careers they receive frequent appraisals as a guide for self development. Company-conducted courses are offered again at all levels of the organization. These help professionals gain the increasingly higher levels of education demanded by the complexities of modern business. Our goal is to see every man advance to the full limits of his capabilities.

If you have other questions or want information on our programs for technical graduates, write to E. G. Abbott, Section 959-9, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR other interviews discussing: • Qualities We Look For in Young Engineers • Personal Development • Salary.**

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